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Popular Science

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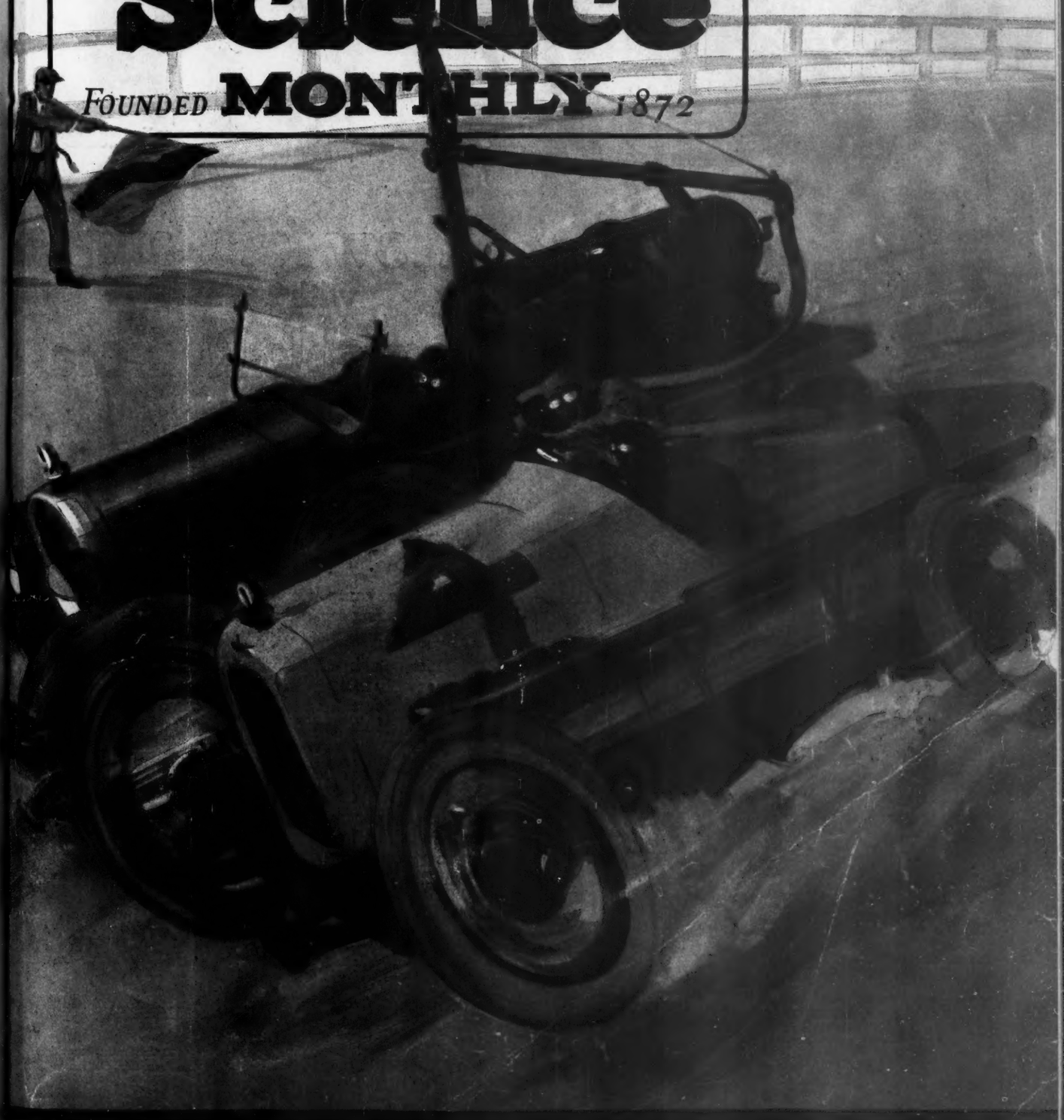


SEPTEMBER

A Marvel of the Speedway (PAGE 31)

25 CENTS

Science Bares Our Hidden Powers (Page 58

Troop No. 1 gets the scores at Camp Schnarr, Ossining, N.Y.

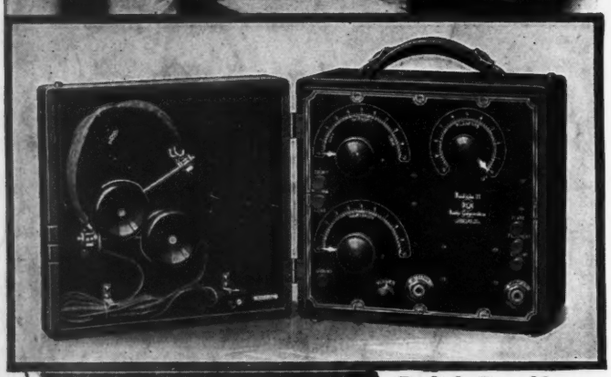
Now for Camp
with the new
Portable Radiola!
(Radiola II)

HERE'S a Radiola you can pick up and trot off with! In a cabinet that holds the headset, the tubes, and all the batteries. With a handle to carry it by. Think of taking your Radiola with you—tuning in almost anywhere, at any time, on half the country's broadcast programs.

Now for camp life with a Radiola! Music at the evening campfire. Baseball scores. Songs, news, talks, going with you wherever you go.

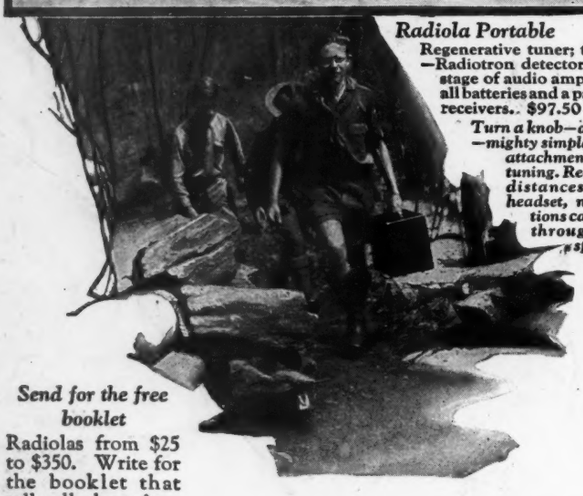
Throw an insulated wire over a tree, and you are ready to listen in to far-away cities. Radiola II is a powerful receiver with two tubes. The secret of its smallness is the new Radiotron UV-199, that operates on ordinary little flashlight batteries!

One thing that will impress the family is the fine appearance of the set for home use, when you take off cover and handle. It's a portable receiver—but, first of all, it's a fine receiver, and a sensitive one.



Radiola Portable
Regenerative tuner; two tubes —Radiotron detector and one stage of audio amplification; all batteries and a pair of head receivers. $97.50

Turn a knob—and tune in —mighty simple. Vernier attachment for fine tuning. Receives long distances with the headset, nearby stations can be heard through a loud speaker.



Send for the free booklet
Radiolas from $25 to $350. Write for the booklet that tells all about 'em.

"There's a **Radiola** *for every purse"*
at the nearest Radio or Electrical Store

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Dept. 2080. Address office nearest you.
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433 California Street
San Francisco, California

Radiola

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Three new Victrola models

Victrola No. 400
Mahogany, $250 Electric, $290

Victrola No. 405
Walnut, $250 Electric, $290

Victrola No. 410
Mahogany, $300 Electric, $340

The three new Victrola models illustrated herewith incorporate Victrola musical quality in cabinets reflecting all the skill of the master designers of other generations—a perfect combination of art and utility with moderate cost, resulting from our unequalled facilities and long experience.

Fully equipped with albums, Victrola No. 2 sound-box, new improved Victor tapering tone-arm and goose-neck sound-box tube, full-floating amplifier, speed indicator and the simple, reliable Victor motor.

Built entirely in the Victor factories, which are the largest devoted entirely to the production of one musical product.

In buying a talking-machine consider that you must choose the Victrola or something you hope will do as well and remember that the Victrola—the standard by which all are judged—costs no more.

A selected list of Victor Records illustrating Victor quality

Lucia—Sextet	Galli-Curci, Egener, Caruso, de Luca, Journet, Bada	95212	$3.50
Berceuse from Jocelyn	McCormack and Kreisler	89106	2.00
Elegie—Mélodie	Caruso and Elman	89066	2.00
Song of the Volga Boatmen	Chaliapin	88663	1.75
Whispering Hope	Gluck and Homer	87524	1.50
Ave Maria (Schubert)	Heifetz	74563	1.75
Minuet in G (Paderewski)	Paderewski	74533	1.75
La Capinera (The Wren)	Galli-Curci	64792	1.25
Traviata—Prelude / Waltz of the Flowers	Victor Symphony Orchestra	35717	1.25
National Emblem March / Lights Out March	U. S. Marine Band / Arthur Pryor's Band	18498	.75

Victrola

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Look under the lid and on the labels for these Victor trade-marks.
Victor Talking Machine Company, Camden, N.J.

POPULAR SCIENCE MONTHLY

Most Wonderfully Illustrated Magazine in the World

SEPTEMBER, 1923; Vol. 103, No. 3
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

SCIENCE moves its products rapidly from the laboratory into the home. Most of us remember when automobiles were called "horseless carriages," when airplanes were considered impractical, when radio was unknown. Yet today 11,000,000 Americans operate automobiles. We no longer marvel at the airplane. There are radio sets in three or four million homes. To an ever increasing degree we depend upon applied science in our daily lives.

* * *

ON PAGE 63 of this issue, Jack Binns, our radio editor, tells simply and graphically of new hook-ups, understanding of which, heretofore, has been confined largely to a little circle of technicists. Another article of absorbing interest to the man who knows the inspiration of the phrase, "do it yourself," is that of Victor H. Todd on mending household electric heating apparatus, page 67. Harold F. Blanchard, noted automobile engineer, in a story filled with hints for the motorist, page 71, points out how to get the most for your money when you buy a car. Such articles, in this day of applied science, interpret science in terms that are personal to all of us.

* * *

SCIENCE has captured and bottled insulin, a remedy for diabetes. The dramatic story of this achievement, one of the most far reaching in medical annals, is told on page 23. One by one the terrible maladies afflicting the human race are being conquered. Cancer may be next. A 300,000-volt X-ray machine, now being tested in Philadelphia, bombards the diseased tissues with minute particles thrown from radium at a tremendous speed. It may solve the cancer problem.

* * *

A NEW fire breaks out in some American home every four minutes. And with almost every forward step in science and invention come new fire hazards. The motion picture brought inflammable film; the automobile brought gasoline. Turn to the story told by Chief John Kenlon, of the New York City Fire Department, on page 36 and read how modern fire fighters call science to their aid. Chief Kenlon believes that scientific fire prevention can add years to the life of the average structure. "Modern fire fighting is a scientific profession, comparable with no other more than to that of medicine," he says.

* * *

IN AN arresting story on page 33, Raymond J. Brown points out the ever increasing dangers from poisonous automobile gases. It is suggested that an upward turned exhaust releasing the fumes above the top of the car may help temporarily. But as the number of cars on our streets increases, such a plan would not afford permanent relief. Scientific ingenuity may be depended upon, however, to find a better solution to the problem.

* * *

PERHAPS the most constantly recurring question in science today is that of evolution. In this month's chapter of the "Story of Man and His World," page 26, Dr. E. E. Free presents the "proofs of evolution." In a fascinating way he unravels the world riddle of existence. He bases his reasoning upon centuries of laboriously gathered scientific facts. Whether or not you agree with Doctor Free, you will find his story this month absorbingly interesting.

* * *

WILL the sun ever fail us? Robert E. Martin asks this question in a stimulating article on page 41. Remember that all our fuel—all our food—everything in life—we get from the sun. Some day chemists may find a way to produce artificial food without the help of the sun. Thus far, however, our bodies live by digesting sunbeams.

* * *

A DISTINCTIVE article is that of Dr. James J. Walsh on "Auto-Suggestion," page 58. Doctor Walsh tells vividly how men may harness their minds and make them work for them. He points out the connection between the satisfaction that comes with the knowledge of a good job well done, and success.

See Table of Contents on page 118

POPULAR SCIENCE MONTHLY

Issued monthly. *Single copy*, 25 cents. *Yearly subscription to United States, its possessions, and Canada*, $2.50; *foreign countries*, $3.

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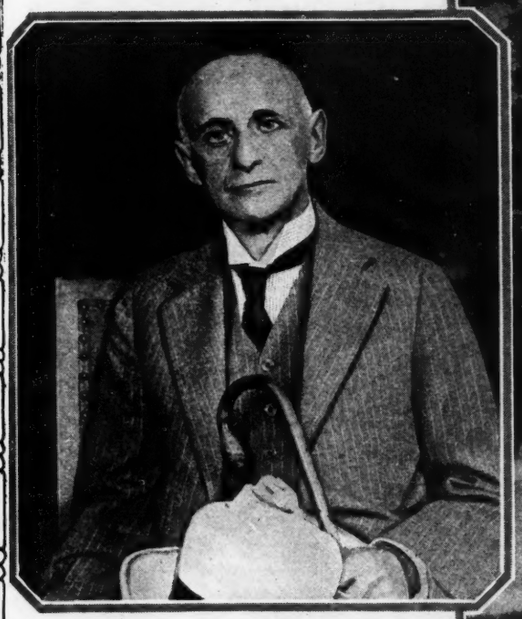
H. J. Fisher, *President*; R. C. Wilson, *Vice-President*
O. B. Capen, *Secretary and Treasurer*

THEY SAY—Brief Bits of Timely Comment On the Sciences of the Hour



DR. SIMON FLEXNER, director Rockefeller Institute of Medical Research, discussing the $150,000 gift of John D. Rockefeller, Jr., to 15 hospitals in the United States and Canada to promote the use of insulin in the treatment of diabetes, as described on page 23 of this issue:

"Insulin is one of the greatest discoveries of modern times. There is no question about its efficiency. Its use, of course, is supplemented by the usual regard for special diet, but it adds enormously to simplification of present methods.

"Insulin patients can be trained to direct their own after-care, and treat themselves."

Alfred B. Hitchens, Ph.D., F.R.P.S., F.R.M.S., F.C.S.

ALFRED B. HITCHENS, PH.D., Director of the Research Laboratory of the Ansco Company, Binghamton, N. Y., who has discovered a means of diagnosing diseases by a special application of photography:

"Photography can be of the greatest help in establishing and portraying unique disease characteristics. It is well known that with proper selective color filters and suitable color sensitized photographic emulsions, details of color and structure can be detected beyond the range of the microscope.

"I have found that there is a definite photo-organic change for specific diseases. By means of specially prepared selective filters and specially sensitized photographic emulsions, these changes can be differentiated photographically."

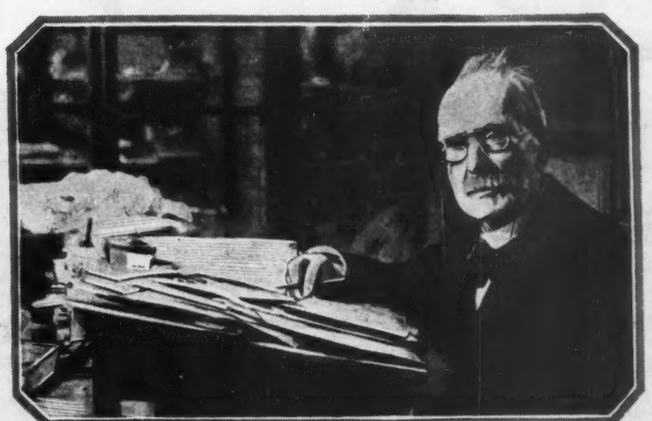
CALVIN COOLIDGE, Vice President of the United States:

"This era has come to be recognized as the scientific age. On this side of life the world is vividly alive and thoroughly interested. It is making larger and larger demands of the schools, of the press, and of every other avenue that provides technical skill and scientific knowledge.

"Yet when success in this direction is not secured, or, being secured, it fails somehow to satisfy, there is a tendency to begin to criticize our institutions and the standards of society as though they were in some way to blame. Sometimes this goes so far as to advocate a complete change in the attitude of the Government toward property rights. More generally this takes the form of some proposal for extended government control.

"Individual initiative in the long run is a firmer reliance than bureaucratic supervision. We do not need more government; we need more culture. We do not need more laws; we need more religion."

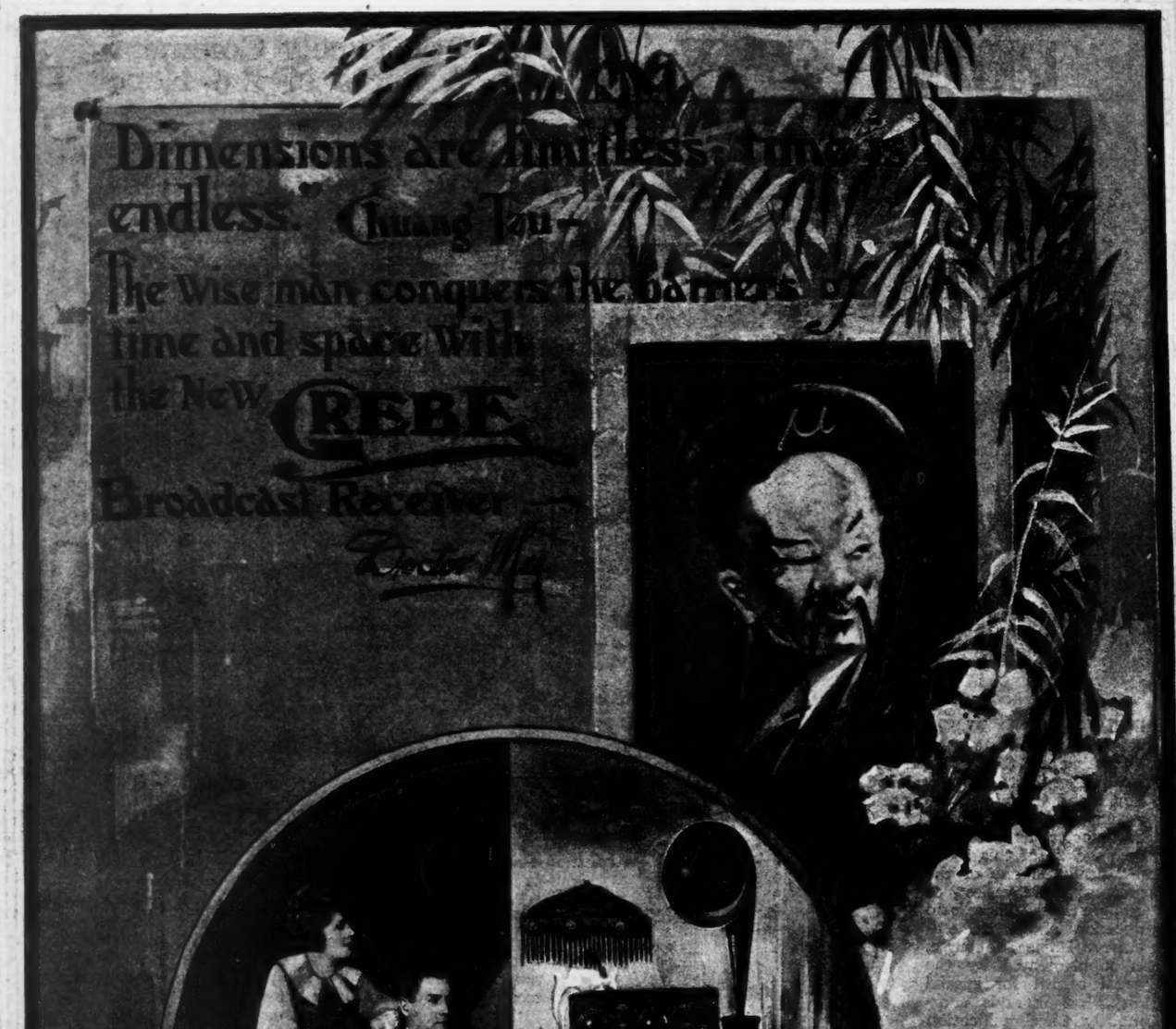
EDOUARD BRANLEY, known as France's "father of wireless," who at the age of 77 announces that he has succeeded in transmitting by wireless not only a luminous point but a circle of light, thereby proving that vision by wireless might become possible at almost unlimited distances:



Edouard Branley, France's "father of wireless," in his study

"It probably will not be long before people are seeing over wireless, as Edouard Bélin suggests. Theoretically it is a sound idea. We have shown that high frequency oscillations of ether waves carry sound vibrations, and Bélin's results so far indicate that the original idea might be applied to other waves. Perhaps we may be able to carry heat by wireless some day—who knows?

"Of course there are too many new and great difficulties to overcome to predict just when new achievements may be expected."


"Dimensions are limitless, time is endless." Chuang Tzu—
The Wise man conquers the barriers of time and space with the New
CREBE
Broadcast Receiver
Receive all broadcasting without outdoor antenna, loop, or storage battery!
This Receiver employs Regeneration and Tuned Radio Frequency Amplification with only two simple tuning adjustments.
Write for "Seven Points of Satisfaction".
CREBE RADIO

POPULAR SCIENCE MONTHLY
SUMNER N. BLOSSOM, Editor
SEPTEMBER, 1923

Insulin—A Miracle of Science

How a Young Laboratory Assistant Won World Fame by Discovering Serum that Offers Relief to Millions of Diabetes Sufferers

By Donald Harris

FROM six hospitals in the United States a few weeks ago came some news that electrified the scientific world. A serum derived from the entrails of animals, given to the hospitals for clinical test of its efficacy as a treatment for diabetes, had proved so extraordinarily successful in administration to many hundred patients, that the physicians who conducted the tests asserted without qualification that it appeared to be a sure method of controlling the disease.

What "Insulin" Means

The new serum is insulin, a name derived from the Latin word meaning "island." This name was applied because the particular groups of intestinal cells from which the serum is extracted are known in medicine as the "Islands of Langerhans."

Since the first announcement of the successful tests of insulin, eminent medical men have been almost a unit in declaring that through its general use probably will be sounded the death knell of diabetes, a disease which until now has resisted the best efforts of medical science.

Injecting insulin into the arm of a diabetes sufferer in the insulin clinic of the Montefiore Hospital, New York City. Dr. Benjamin Duborsky is shown administering the new serum

Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, has said that insulin promises to prove "one of the great medical contributions to the world."

Dr. A. I. Ringer, in charge of the test of insulin at the Montefiore Hospital in New York, stated unequivocally that "insulin is undoubtedly one of the greatest discoveries of the age," and that, now that it has been given to the world, "no person should die of diabetes."

Dr. Nellis B. Foster, writing in the "New York Medical Journal," declared, "I think it is safe to say that could one start with insulin before operation, one could be reasonably sure that the patient would not die of diabetes."

Other medical authorities expressed their indorsement of the new serum with equal enthusiasm, and John D. Rockefeller, Jr., only a few weeks ago contributed $150,000 to permit 15 hospitals in the United States to introduce the use of insulin in their clinics.

Probably the most amazing and dramatic feature of this remarkable discovery is the personality of its discoverer. The man who gave insulin to mankind was no famous medical authority, nor was he even a recognized scientist, trained in the intricacies of research, fortified by exhaustive knowledge of medical lore, and possessing extraordinary equipment in laboratory and materials. Instead, he was an obscure Canadian doctor of 31, less than six years out of medical college, a farmer's son, who had accepted with pride a humble position as a laboratory assistant in a Canadian university when he returned wounded from war service only three years ago.

Moreover, the most valuable part of the discoverer's work was accomplished in the incomplete home laboratory of a young Toronto doctor, a school friend, who permitted him the use of his home and equipment merely because he, the owner, was going away on a vacation and had no use for them.

The discoverer of insulin is Dr. Frederick Grant Banting. Probably there is no better illustration of the general attitude of the medical profession toward him and his discovery than the recent comment of Doctor Flexner:

Where Experts Failed

"No one had ever heard of him. In fact, there was no reason why any one should have heard of him.

"This young doctor didn't know much about diabetes. Quite by chance he discovered how to get insulin and use it as a cure. At Toronto he proved the efficacy of his treatment. We experienced physicians who had so much material and so much scientific background to help us find a cure for diabetes, failed. We feel like kicking ourselves.

"The world is enormously richer today as a result of Doctor Banting's discovery of insulin. It seems to me that mankind never again will be in the grip of this disease as it has been for so long. There is still a bit of danger in its use, but some day we shall all know just how to administer it. Then all the world, every hamlet of it, will appreciate the benefits."

In speaking of "chance" as a factor in Doctor Banting's discovery, Doctor Flexner had no intention of belittling either the discovery or the discoverer. The truth is that in what Doctor Banting has accomplished, chance played a prominent part, and no one is more ready to admit the fact than he.

Diabetes is caused by the failure of the Islands of Langerhans properly to perform their functions. In the normal man these "islands" secrete insulin—the same insulin which now is taken from animals to supply a means of fighting diabetes.

Carbohydrates—foods of a starchy sort—are converted into sugar, which is absorbed by the intestines. Part of the sugar is carried to the liver, where it is stored as glycogen, or animal starch. The remainder is carried by the blood to the muscles and other tissues, where some of it is oxidized and some stored as glycogen.

Insulin secreted by the normal man passes directly into the blood, there combining chemically with the sugar substances formed from food to supply the body with elements necessary to the health. In diabetes, the insulin fails to perform its chemical action on the sugar substances. This causes them to circulate in large quantities through the blood and to be lost in excretions. The body, in consequence, is deprived of an important source of energy. Among the symptoms of the disease are voracious appetite and abnormal presence of sugar in the blood and certain bodily excretions.

What Causes Diabetes

The medical profession long had known that the removal from an animal of the Islands of Langerhans resulted in symptoms of diabetes. Also, marked destructive changes in the "islands" were noted in the majority of patients who suffered from diabetes. The conclusion, of course, was that a derangement of the secretions from the "islands" was the cause of the disease. Investigators had arrived at the belief that extracts of the secretions from the "islands" obtained from animals might supply a serum, which, by supplying to diabetics the insulin which nature was failing to produce, would form an effective treatment for the disease.

Langerhans, the German physician for whom the "islands" are named, and others had expressed this opinion in treatises, but attempts to obtain pure insulin proved futile, since it was destroyed invariably by the powerful digestive ferments present in the extracts which were made.

Dr. Banting Begins Research Work

In November, 1920, Doctor Banting, having chanced upon Langerhans's work on the subject of diabetes, became interested in the possibility of developing the serum, and began experimenting at the laboratories of Western University, where he had been a laboratory assistant for a few months. He discovered this work to be so engrossing that he applied for a two months' leave of absence and set up a laboratory at the home of Dr. F. W. Hipwell in Toronto. Doctor Hipwell was a school and college friend, who was leaving the city for a vacation. The two months' leave was extended to three, and at the end of that time Doctor Banting resigned from the university, for his experiments were progressing with encouraging success.

In attempts to extract pure insulin from the intestinal tracts of animals, previous experimenters had shown that by tying up the ducts from whence came the digestive juices, degeneration occurred much more rapidly in the juices than in the Islands of Langerhans. After many months of work, Doctor Banting conceived the idea that if an extract were prepared from the intestinal tissue remaining, some time after the ducts had been tied, it should contain insulin because there would not be enough of the digestive ferments to destroy it.

In 1921 his experiments in this line proved successful; he obtained the serum he sought in a comparatively pure state and devised methods of refining it further, removing from it substances that rendered it unsuitable for repeated injection in man.

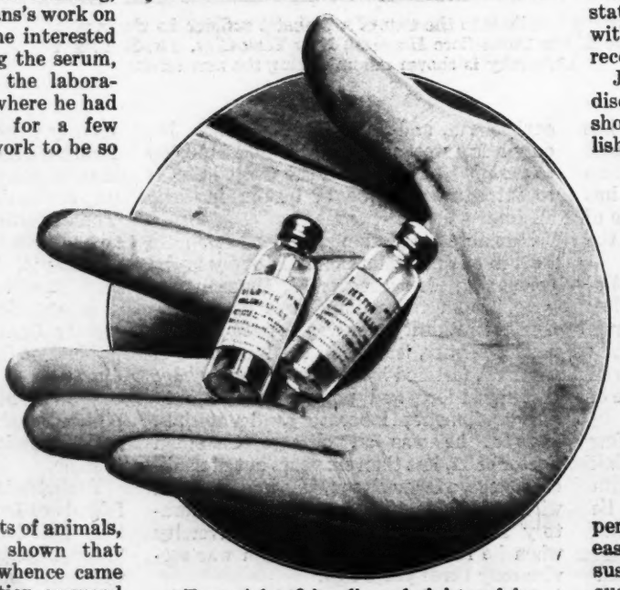
By this time his experiments had reached a stage that led the authorities of the University of Toronto to permit him to pursue his work in the famous Connaught Laboratories. It was from there, after several months' intensive work to determine the effect of insulin on normal and diabetic animals, that the announcement was made that the Banting serum was ready to be offered to the medical profession for clinical test. In his work at the university, Doctor Banting was assisted by Dr. J. J. McLeod, Dr. C. H. Best, and others.

Dr. Frederick Grant Banting

BY HIS discovery of insulin, a serum used with amazing success in the treatment of diabetes, Dr. Frederick Grant Banting, 31 years old, son of a farmer and a laboratory assistant in a Canadian university, suddenly finds himself lifted from obscurity to worldwide fame.

John D. Rockefeller, Jr., recently donated $150,000 to permit 15 hospitals in the United States to introduce insulin.

The Canadian Government has granted Doctor Banting an annuity of $7500 a year for life. Ontario Province has appropriated $10,000 a year to found a department of research at Toronto University, $6000 to go to Doctor Banting as its head.



Two vials of insulin, administered by injection into the patient's arm

Successful Tests in United States

The results of the tests of insulin conducted in six hospitals in the United States, have been entirely successful. Previous to the introduction of insulin, the accepted treatment for diabetes was dietetic, limiting the quantities of starches and sugar taken in food. This method of treatment was unsatisfactory, since the inadequate diet resulted in great loss of strength and energy, and since lapses from the severity of the prescribed diet resulted in recurrence of the diabetic symptoms.

Using insulin, physicians now are able to permit their patients a strength-sustaining diet during treatment. The serum, which usually is injected in the arm, restores to the body its normal power of transforming starches, sugars, fats, and similar food into the chemical constituents necessary for health.

Many of the patients whom the clinical directors pronounced cured of diabetes by insulin had been in a diabetic coma from which only a handful of sufferers ever had emerged previously. Five who had been in this last stage of the disease were treated and discharged at the Montefiore Hospital alone.

Robert Lansing Is Aided by Insulin

Prominent among those whom insulin has helped is Robert Lansing, former Secretary of State, who had been a sufferer from diabetes for years. Recently he stated that, after six weeks' treatment with insulin, he was well on the road to recovery.

Just how important Doctor Banting's discovery is to the health of the nation is shown by mortality statistics recently published by the United States Census Bureau. These reveal that for 20 years the number of deaths from diabetes has been increasing steadily in the United States with a really startling increase since 1919.

In New York State the rate of mortality from diabetes is highest—22 in 100,000. New Jersey, Pennsylvania, and Ohio also show very high rates, while in the West and South, deaths from this disease are comparatively few. The variations are due, not to differences in climate, it has been explained, but to the recognized varying susceptibility to diabetes of different classes of the population. Thus, old persons are more prone to contract the disease than the young; white persons are more susceptible than colored; women are more susceptible than men. Among the white

(*Turn to page 112*)

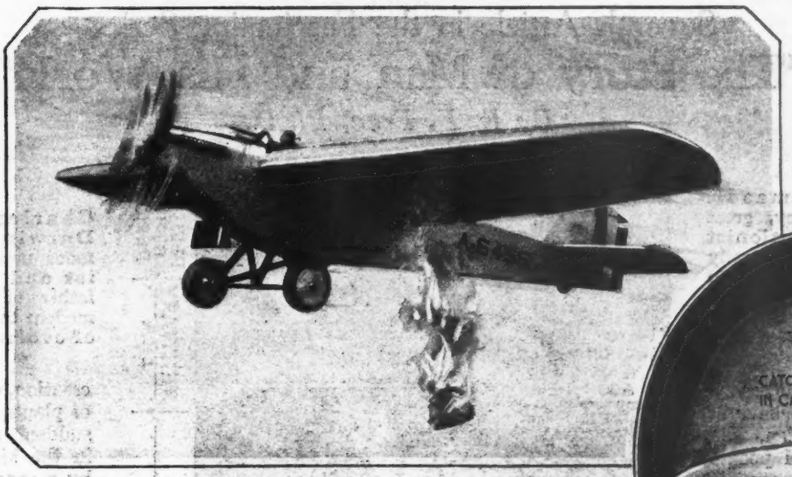
New Airplane Conquers Fire Peril

A GRAY monoplane —the A-6455— soared gracefully over the Glenn L. Martin flying field, Cleveland, Ohio. Up, up it went, while a little group of spectators on the ground watched with nervous expectancy.

Suddenly there was a burst of flame from the engine. The whole hood seemed in flames. A second tongue of fire shot out from under the wings where the gasoline tanks nested.

Then, while naval experts and aviators below held their breath in suspense, the shooting flames suddenly were snuffed out as if by magic; the mushroom-shaped gas tanks hurtled from the wings, blazing, but harmless, to the ground, and the plane volplaned safely to earth.

The pilot stepped out. One of the most ruthless enemies to man's conquest of the air—fire—had been defeated.



Dropping a flaming gasoline tank from the wing of the navy plane A-6455 during fire safety test above the Glenn L. Martin flying field, Cleveland, Ohio. Note how the tank clears the landing gear. The plane landed safely

Below is the mushroom-shaped, releasable gas tank. In case of fire, a lever controlled by the pilot cuts a soft metal gas line and releases catches that hold the tank to the airplane

Emergency Levers Do the Trick

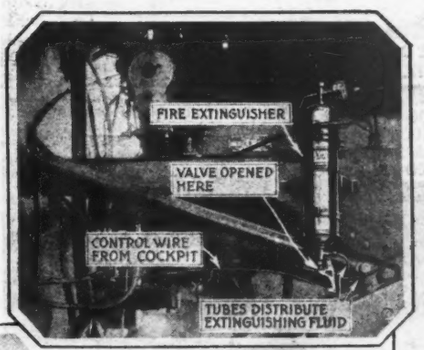
To accomplish this amazing feat, the aviator, after deliberately setting fire to the gas tank, and to the engine, simply had pulled two levers. The first lever flooded the blazing engine with fire-extinguishing fluid; the other cut the soft metal tubes from the gas tanks to the engine. At the same time, this second lever released trip catches that held the tanks under the airplane wings, and the tanks fell blazing to the ground.

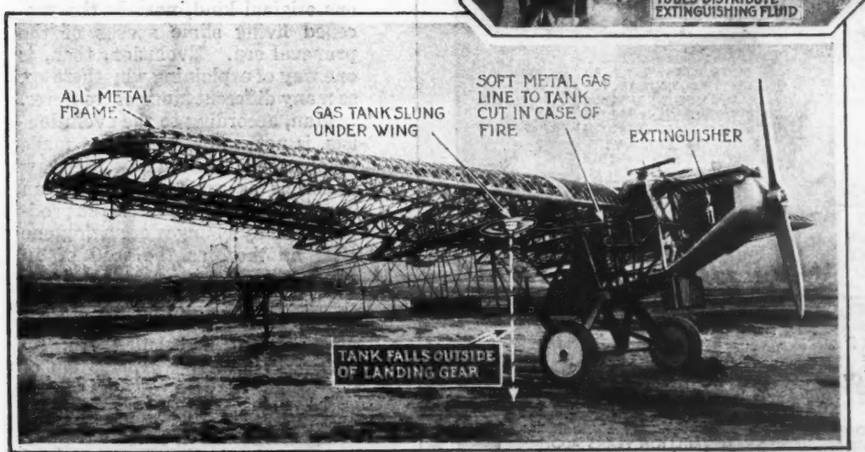
How to safeguard the airplane from the appalling fires that during the war took heavy toll of the lives of aviators, is a subject upon which airplane makers have racked their brains and have spent much time and money. Until the recent successful test described above, all attempts at a solution had failed. But now United States naval officials, in conjunction with the Glenn Martin Company, believe they have perfected a thoroughly satisfactory safeguard.

The first plane to be equipped with the new devices is a navy all-metal plane, used for spotting gunfire. Every part of this machine, except the linen wing covering, is built of duralumin, the aluminum alloy that is almost as light as aluminum and nearly as strong as steel. The two gasoline tanks are of mushroom shape and are set one into each wing on the under side.

The fire-extinguishing device is a specially built pressure extinguisher, mounted under the engine hood, where most of the airplane fires start. The enormously rapid combustion of gasoline that makes the power also makes heat, and sometimes the engine backfires. Either of these causes may ignite the oil, causing a disastrous fire, often resulting in the death of the pilot.

In the new navy plane, the pilot simply pulls a knob mounted on the dash in the cockpit. This knob, by means of a wire, opens the extinguisher valve. Distributing tubes carry the fluid to all parts of the engine, spraying them thoroughly and quickly putting out the fire.




ALL METAL FRAME
GAS TANK SLUNG UNDER WING
SOFT METAL GAS LINE TO TANK CUT IN CASE OF FIRE
EXTINGUISHER
TANK FALLS OUTSIDE OF LANDING GEAR

The all-duralumin frame of the fireproof plane, showing position of the releasable gas tank beneath the wing, and the fire extinguisher in the hood. In case of fire, a lever controlled by the pilot opens a valve in the extinguisher and floods the engine with extinguishing fluid through distributing tubes, as shown in inset

How the Tank Is Released

If by chance the fire should spread to the gas tank, the pilot pulls another lever that cuts the soft metal tubes leading from the tank to the engine, at the same time releasing catches that hold the tank in the wing. The tank falls clear of the landing gear, blazing but harmless, and the pilot is able to make a safe landing.

The linen covering for the wings is carefully fireproofed with chemicals, to prevent it from catching fire during the time it takes the pilot to release the tanks.

In tests, aviators, having set both engine and gas tanks afire, were able to land with practically no damage to the plane and with no peril to themselves.

Next—The Air "Pullman"

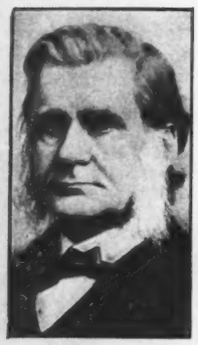
THE remarkable inventions described above sweep away one of the most formidable barriers to successful commercial air transportation—fire. We are but a step from the day when we shall speed across country in luxurious winged sleeping cars, without fear of accident.

Just such an air sleeping car —one that can be adapted to travel either on rails or in the sky—aeronautic engineers even now are designing. It will be described in an early issue of POPULAR SCIENCE MONTHLY, with fascinating and authoritative illustrations.

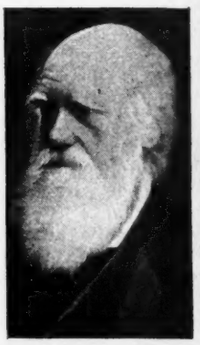
The Proofs of Evolution

Seventh Article in the Fascinating Series, "The Story of Man and His World"

By E. E. Free, Ph.D.



Thomas H. Huxley, great evolutionist and an early contributor to POPULAR SCIENCE MONTHLY



Charles R. Darwin, famous naturalist and the father of the modern theory of evolution

PRACTICALLY all the scientists in the world believe in the theory of evolution. The vast majority of educated people believe in it also. Only a few weeks ago a group of leaders of American thought in science, religion, and public affairs issued a public statement affirming their conviction that evolution is true and that it does not conflict in any essentials with the Christian religion.

To convince this great body of serious and intelligent opinion must have required strong proofs. We must pause now in our story for a recapitulation of these proofs.

What Is Evolution?

Let us consider, first of all, how the theory of evolution came to be formulated and just what this theory means.

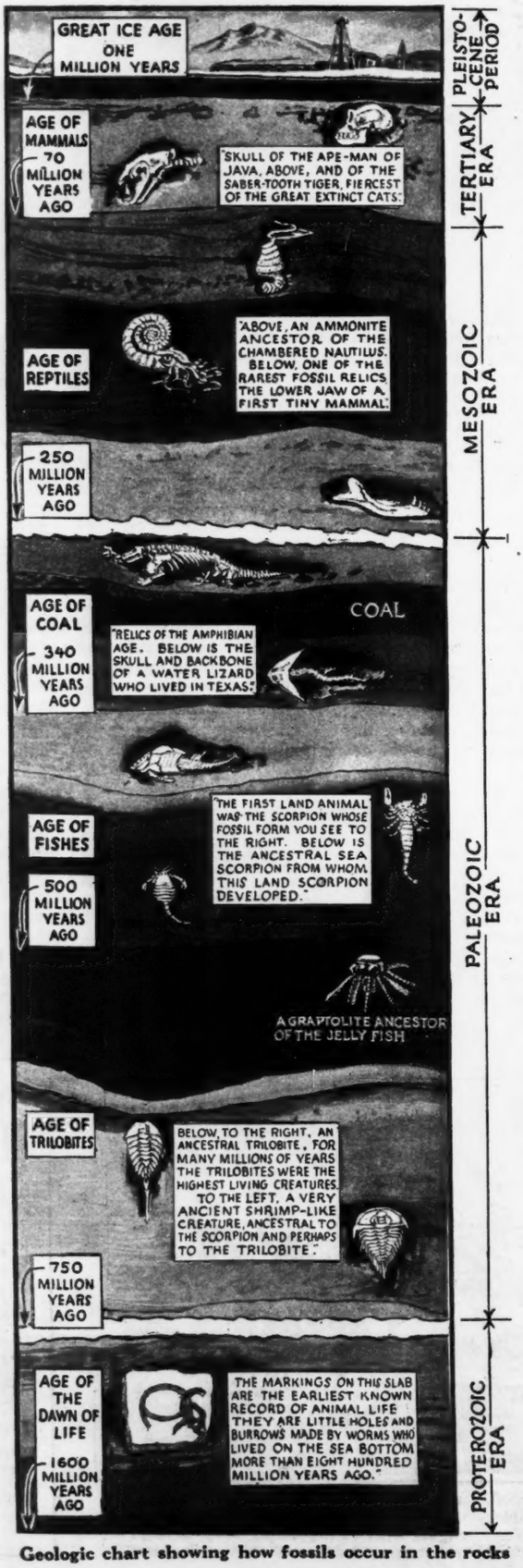
It is a matter of common observation that there exist in the world a great many different kinds of living creatures. You can see perhaps a hundred different kinds of plants and half a hundred different kinds of birds, worms, insects, and other animals on an hour's walk in the country anywhere in the world. The students of natural history estimate that there are now living in the world more than 1,000,000 kinds of animals (including, of course, worms, insects, fish, shellfish, and all the rest) and more than 2,000,000 kinds of plants.

Life in 5,000,000 Shapes

In the rocks that were deposited during previous geologic periods we find the relics of still other kinds of living creatures, now extinct; for example, the great reptiles that we described in previous chapters. Altogether, the different kinds of living creatures, plant and animal, that do live or have lived on our planet, must total well over 5,000,000. A total of 50,000,000 is even more probable.

How did this tremendous number of different creatures come into existence? This question has been asked ever since the time of the ancient Greek philosophers, nearly 3000 years ago. There have been suggested, in essentials, only two answers. One is the answer of special creation. The other is the answer of evolution.

According to the idea of special creation, each one of these millions of plants and animals was created suddenly and complete at some time in the history of the world, each by a special supernatural act.


GREAT ICE AGE
ONE MILLION YEARS
PLEISTOCENE PERIOD
TERTIARY ERA
AGE OF MAMMALS
70 MILLION YEARS AGO
"SKULL OF THE APE-MAN OF JAVA, ABOVE, AND OF THE SABER-TOOTH TIGER, FIERCEST OF THE GREAT EXTINCT CATS."
MESOZOIC ERA
AGE OF REPTILES
"ABOVE, AN AMMONITE ANCESTOR OF THE CHAMBERED NAUTILUS. BELOW, ONE OF THE RAREST FOSSIL RELICS THE LOWER JAW OF A FIRST TINY MAMMAL."
250 MILLION YEARS AGO
AGE OF COAL
340 MILLION YEARS AGO
COAL
"RELICS OF THE AMPHIBIAN AGE. BELOW IS THE SKULL AND BACKBONE OF A WATER LIZARD WHO LIVED IN TEXAS."
PALEOZOIC ERA
AGE OF FISHES
500 MILLION YEARS AGO
"THE FIRST LAND ANIMAL WAS THE SCORPION WHOSE FOSSIL FORM YOU SEE TO THE RIGHT. BELOW IS THE ANCESTRAL SEA SCORPION FROM WHOM THIS LAND SCORPION DEVELOPED."
A GRAPTOLITE ANCESTOR OF THE JELLY FISH
AGE OF TRILOBITES
BELOW, TO THE RIGHT, AN ANCESTRAL TRILOBITE. FOR MANY MILLIONS OF YEARS THE TRILOBITES WERE THE HIGHEST LIVING CREATURES. TO THE LEFT, A VERY ANCIENT SHRIMP-LIKE CREATURE, ANCESTRAL TO THE SCORPION AND PERHAPS TO THE TRILOBITE."
750 MILLION YEARS AGO
PROTEROZOIC ERA
AGE OF THE DAWN OF LIFE
1600 MILLION YEARS AGO
THE MARKINGS ON THIS SLAB ARE THE EARLIEST KNOWN RECORD OF ANIMAL LIFE. THEY ARE LITTLE HOLES AND BURROWS MADE BY WORMS WHO LIVED ON THE SEA BOTTOM MORE THAN EIGHT HUNDRED MILLION YEARS AGO."

Geologic chart showing how fossils occur in the rocks

The Evolutionists' Theory

The alternative idea is that one kind of creature can change into another kind, and this into a third kind, and so on. Some original kind of wildcat, for example, is thought to have changed, gradually and through many generations, one branch into tigers, another branch into lions, a third into the various varieties of domestic cat, other branches into the other existing and extinct kinds of catlike creatures. Similarly, according to this idea, man himself, as we have told in previous chapters, is one of the many branches that have developed from the little tree-living, somewhat catlike creature called lemur that lived fifty or sixty million years ago.

This is the idea of change, of evolution. The theory of evolution may be defined as the idea that certain kinds of creatures, plant or animal, can change into other kinds.

Where Life Began

If this be true, it is evident that all the millions of kinds of creatures, living and dead, that we know to have existed may have originated by change and divergence out of a few kinds in the beginning, or, as most evolutionists believe, out of *one* original kind, namely the one-celled living slime specks of the primeval sea. Evolution, then, is one way of explaining why there are so many different kinds of creatures.

Man, according to the evolutionists, is not a finished device, made all at once out of the necessary raw materials as a sculptor makes an image out of clay. Man is the product of many changes occurring one after another, as the seed of an apple will change in the course of years first into a plantlet, then into a slim sapling, and finally into a spreading and fruit-laden tree.

Defenders of this explanation of the origin of man must produce proofs—proofs that man has developed, age by age, out of a long line of animal ancestors, some of them wormlike, some fishlike, some reptilelike, some monkeylike. Such proofs can be produced.

The more important ones that have been offered can be stated under five heads.

First, the fossils found in the rocks enable us to trace the actual history of life and its evolution.

Second, inside the human body there are numerous organs and parts of organs now useless to us, but which were developed for and used by one or more of our animal ancestors.

Third, many of the workings of the human body also are inherited, quite obviously, from animals that preceded us.

Fourth, the body of a developing child, before birth, passes through stages that recall the bodies of lower animals—worms, fish, reptiles, and others.

Fifth, new kinds of animals and plants actually have been produced artificially by breeding, thus duplicating evolution experimentally.

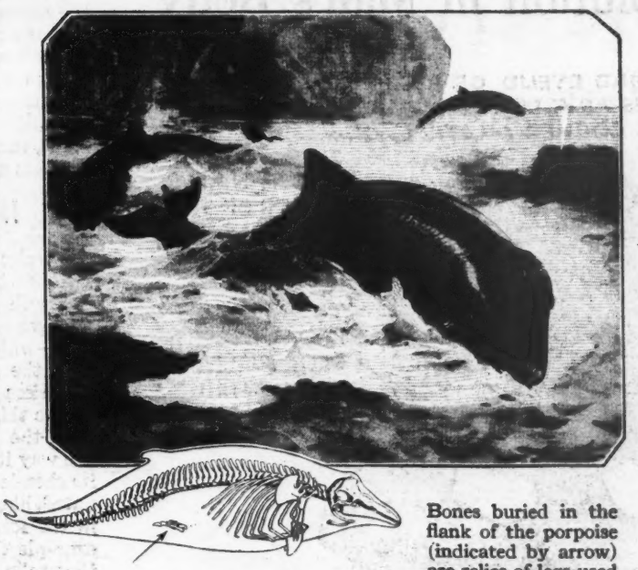
Some of these proofs of evolution have been implied in previous chapters. We have discussed, for example, the recovered bones of fossil men, bones that are clearly intermediate in shape and character between the bones of modern men and of the apes. These are the links, no longer "missing," that tie our bodies to the bodies of the beasts.

Age-Old Rocks Submit Evidence

We have seen, also, that the whole great assemblage of fossils found in the rocks of the earth show a progressive rise of life from the first rocks to the latest ones. In the deepest and earliest rocks we find traces only of the simplest creatures, little one-celled bits of living jelly like the first slime specks or like the microscopic creatures that still live in the water of roadside ditches.

In the upper rocks, of later and later age, we find the life forms growing steadily more complicated and diverse. We can trace by actual fossils dug out from these rocks the main stages in the upward path of life. We can see how the most primitive and simplest forms of life developed into wormlike things, and these into fishes, and these into reptiles, and so on upward to man.

But strong as is this proof of evolution from the fossils, it is no stronger than the second proof, from the body of man itself. The human body, as we said in a previous chapter, is a living museum of the past. Let us consider, for example, that annoying little organ, the appendix.



Bones buried in the flank of the porpoise (indicated by arrow) are relics of legs used by this creature's ancestors millions of years ago when they lived on shore

The appendix is more valuable nowadays to the surgeons who get paid to cut it out than it is to its original possessors. So far as we know, it has no use nor function in the modern human body. But it is an important proof of evolution. It is a vestige of an extra stomach which we used to have and which has disappeared.

The animal ancestors of man were at one time eaters (in part) of roots and grass and the bark of trees and of similar materials, which are, for us, almost totally indigestible. The ordinary digestive juices do not attack such woody substances. There exist, however, certain bacteria that do attack them. When chewed-up bark, for instance, has been acted on by these bacteria, it becomes more or less softened and digestible, just as meat becomes less tough when it is allowed to hang. Therefore, our animal ancestors, who had to eat stuff like this, set aside a part of their digestive system in which these wood-softening bacteria could live. The woody part of the food was held there, in a kind of sack or supplementary stomach, for a few hours or days until the bacteria could soften it. Then the food value in it was absorbed. The grass-eating animals, such as the cow and horse, still have this extra stomach and use it just as our ancestors did.

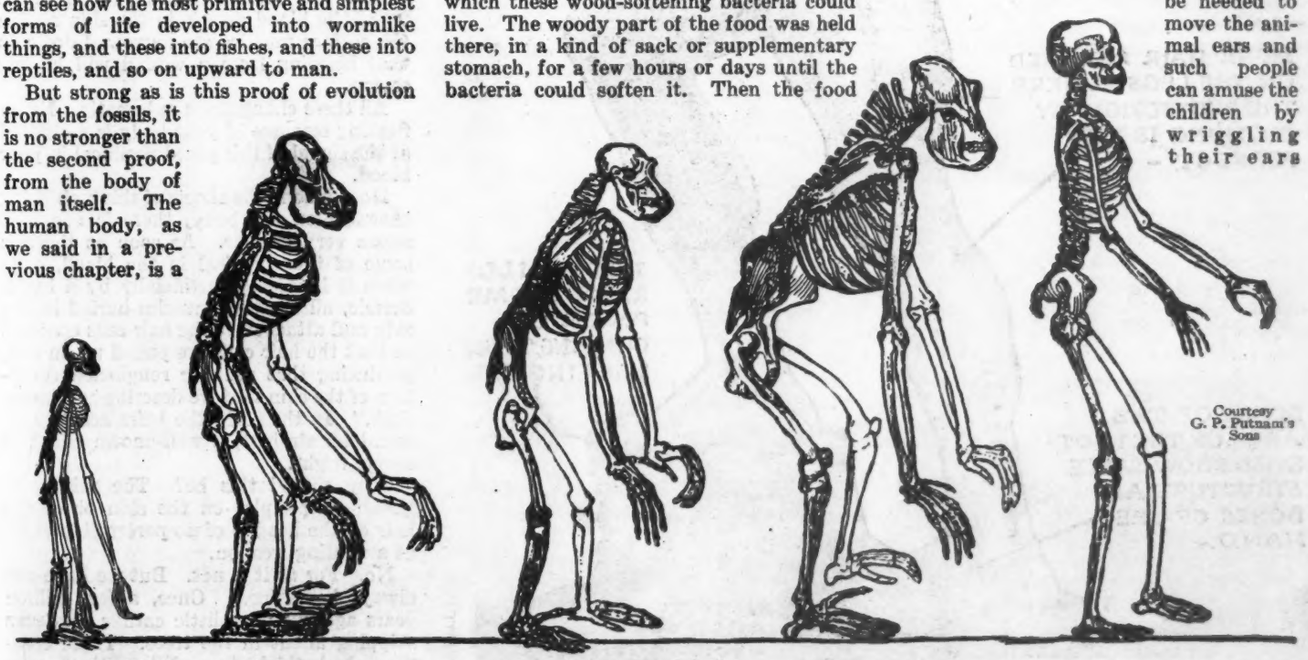
Exit Man's Second Stomach

With the passage of millions of years and with a change of diet for the animals in the human line, the need of this wood-digesting stomach disappeared. The stomach shrank. Now it is represented, in man, only by the appendix, a little tube an inch or two long and about the thickness of a lead pencil, attached at one end to the intestine. It has become so troublesome to us, so liable to disease and inflammation, merely because it has lost its proper job. Like all idlers, it is prone to disturbance and discontent.

There are nearly 200 similar vestige structures like the appendix, structures that have at present no important value to the body, but that were necessary to some one of our animal ancestors.

One of them is the pineal gland in the brain of modern men, an organ that is the vestige of a third eye that some of the ancient reptiles had on the top of the head. There is still living, in New Zealand a reptile, one of the "living fossils" mentioned in a previous chapter, that has on top of its head a structure determinably an eye, though not one that can be used to see with. How can we explain this living reptile? How can we explain the vestige of another eye inside our own brains and the brains of other modern mammals except by inheritance from those extinct reptilian ancestors of ours who had this third eye and whose fossil skulls, showing the telltale third eye-hole, we have found in the rocks?

There is space to mention only a few of the other vestige organs. Man's fossil ancestors had 13 ribs; man has only 12. But sometimes a man is born with 13. Some people still possess the muscles that used to be needed to move the animal ears and such people can amuse the children by wriggling their ears

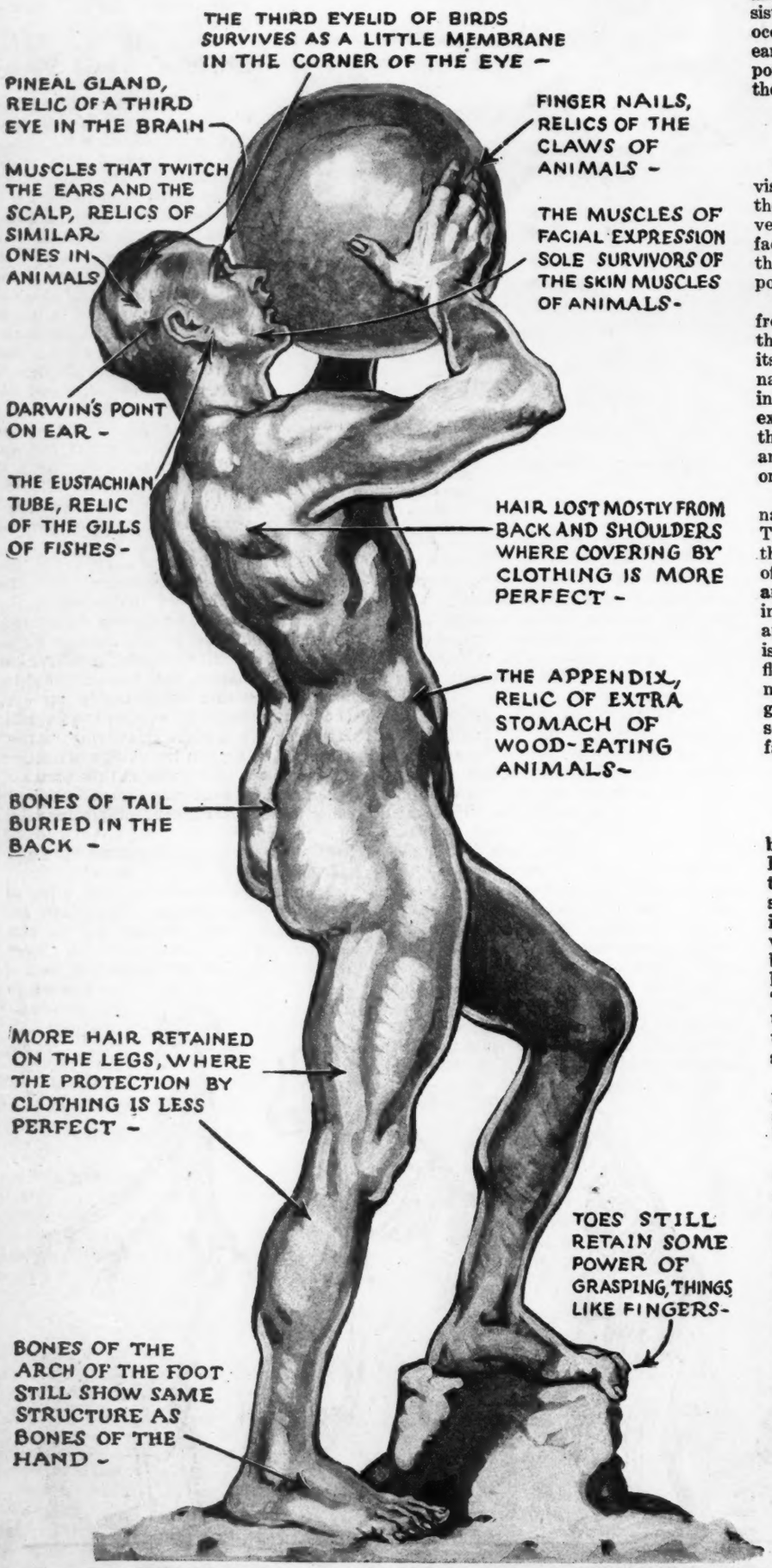


Courtesy G. P. Putnam's Sons

GIBBON ORANG-UTAN CHIMPANZEE GORILLA MAN

A glance at the skeletons of man and the apes shows how similar they are to each other

Relics of Evolution in Man's Body


THE THIRD EYELID OF BIRDS SURVIVES AS A LITTLE MEMBRANE IN THE CORNER OF THE EYE –
PINEAL GLAND, RELIC OF A THIRD EYE IN THE BRAIN –
MUSCLES THAT TWITCH THE EARS AND THE SCALP, RELICS OF SIMILAR ONES IN ANIMALS
FINGER NAILS, RELICS OF THE CLAWS OF ANIMALS –
THE MUSCLES OF FACIAL EXPRESSION SOLE SURVIVORS OF THE SKIN MUSCLES OF ANIMALS –
DARWIN'S POINT ON EAR –
THE EUSTACHIAN TUBE, RELIC OF THE GILLS OF FISHES –
HAIR LOST MOSTLY FROM BACK AND SHOULDERS WHERE COVERING BY CLOTHING IS MORE PERFECT –
THE APPENDIX, RELIC OF EXTRA STOMACH OF WOOD-EATING ANIMALS –
BONES OF TAIL BURIED IN THE BACK –
MORE HAIR RETAINED ON THE LEGS, WHERE THE PROTECTION BY CLOTHING IS LESS PERFECT –
TOES STILL RETAIN SOME POWER OF GRASPING, THINGS LIKE FINGERS –
BONES OF THE ARCH OF THE FOOT STILL SHOW SAME STRUCTURE AS BONES OF THE HAND –

Above are indicated some of the organs developed by man's animal ancestors for their use millions of years ago, vestiges of which survive in modern man

backward and forward. In the corner of the human eye there is a little fold of skin that is a remnant of the third eyelid of the ancient reptiles, a structure that still persists in our distant cousins, the birds. An occasional person has on the top edge of his ear a little sharp point, known as Darwin's point, that is a vestige of the pointed ear of the cats and insect-eaters.

Whales Once Had Legs

Whales and porpoises have no legs—visibly—but underneath the skin, buried in the flesh of their sides, are the shrunken vestiges of leg bones, telltale relics of the fact—which we know also from the fossils—that the remote ancestors of whales and porpoises were land dwellers and had legs.

The third proof of evolution is the proof from the *actions* of the human body, from the way it works. The habits of the body, its chemical and physical machinery, originated, like its anatomical structure, far back in the forgotten past. Let us take as an example the chemical (and other) changes that take place in the body unconsciously and involuntarily whenever we are angry or afraid.

Two of the so-called ductless glands are named by scientists the adrenal glands. They are little lumps of tissue, each about the size of half a walnut, placed one on top of each kidney. These adrenal glands have, among other functions, the duty of preparing the body for a fight. Whenever you are angry or afraid, whenever you realize, that is, that you may soon have a fight (or a flight) on your hands, an emergency nerve message goes to these adrenal glands. The glands discharge immediately into the blood some of a certain chemical that they manufacture.

When the Adrenals Get Busy

This chemical has profound effects on the body, especially on the blood and the heart. It quickens the circulation and at the same time it causes the size of certain blood vessels to change so that less blood goes to the internal organs, which you do not need while fighting, while more blood goes to the brain and muscles that may have to work harder and more accurately than usual. The little blood vessels in the skin and in the surface muscles are narrowed down so that bleeding from a wound will be less severe.

All these changes are automatic. Every fighting resource of your body is mobilized at the signal of this gland chemical in your blood.

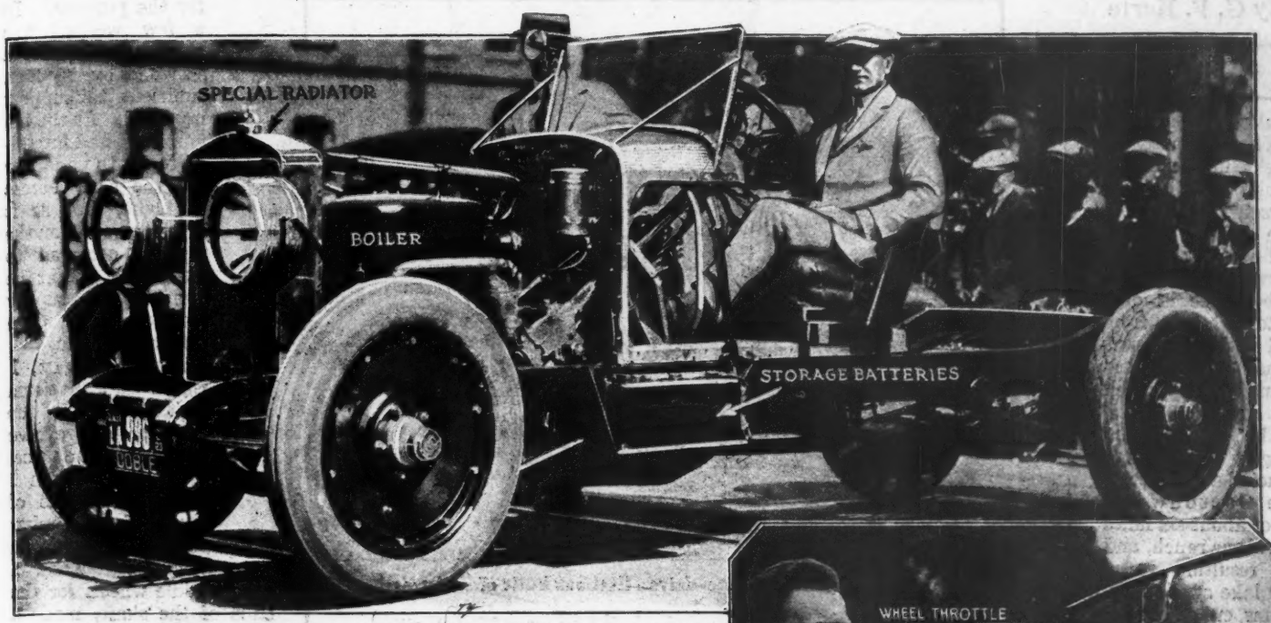
Now, among the effects of this mobilizing chemical on the body, there is one that seems very curious. As soon as there is some of the chemical in the blood, even when it is injected artificially by a hypodermic, all the tiny muscles buried in the skin and attached to the hair cells contract so that the hair cells are pulled up on end, producing that peculiar roughened condition of the skin that we describe as "gooseflesh." In the scalp the hairs actually do stand up straight, a well-known effect of severe fright.

Why should this be? The raising of gooseflesh pimples on the skin or of the hair on the head is of no perceptible value as a fighting weapon.

No. For *us* it is not. But we have not always been "us." Once, a few million years ago, we were little catlike creatures skipping about in the trees. These creatures had thick fur. When they were frightened, they ruffled it up, doubtless,

(*Turn to page 98*)

New Steam Car Starts in 30 Seconds



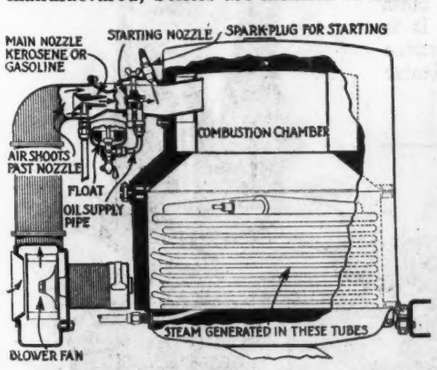
The improved Doble steam car, with hood removed to show position of the boiler. At right: Control mechanism, showing wheel throttle

WITH such authorities as th United States Bureau of Mines continually reminding us we are consuming our petroleum resources at an excessive rate and that we can count on this source of power for the automobile for only a comparatively few years, engineers and inventors have been urged to develop the steam car to a greater degree of perfection. After 12 years of steady work, Abner Doble, of San Francisco, has constructed a steam automobile possessing improvements that mark it as a distinct forward step in the evolution of efficient steam power plants.

Drawbacks of the Steam Car

The difficulties with most steam automobiles has been the time required to get up steam for a start and their complexity of operation as compared with gasoline cars. They have had more parts than the gas car, and their engines have possessed more vulnerable points. In addition, since so many more factors had to be taken into consideration, it has been deemed desirable to install automatic controls. This feature has introduced other ways in which the engine may go wrong, adding to the owner's difficulties in keeping his car in first class condition.

In most steam cars that have been manufactured, boilers are inclined to burn out, scale tends to form on the inside of the boiler tubes, and pilot lights have the habit of going out. All of these drawbacks have made it impossible for the steam car to compete with the gasoline car in spite of its undisputed superiority in fuel economy.



The steam generating plant. Note position of combustion chamber where fire is applied above steam coils

Doble has succeeded in eliminating a great many of these disadvantages. His greatest achievement, probably, lies in the perfection of a quick-action starting mechanism. Instead of the usual pilot light for steaming up, he uses a spark plug actuated by a storage battery. Compressed air, stored in a tank, is released and allowed to shoot past a nozzle. This causes a suction that draws a rich mixture of fuel, either kerosene or gasoline, in the form of a spray, into the combustion chamber, where it is ignited by the spark plug. The heat is very intense. In fact, Mr. Doble claims that a pressure of 750 pounds of steam can be obtained in 30 seconds.

During the first five seconds the fuel is supplied by the starting nozzle. Thereafter the spark automatically stops, the compressed air stops flowing, and a blower motor provides the air that draws fuel from a main nozzle.

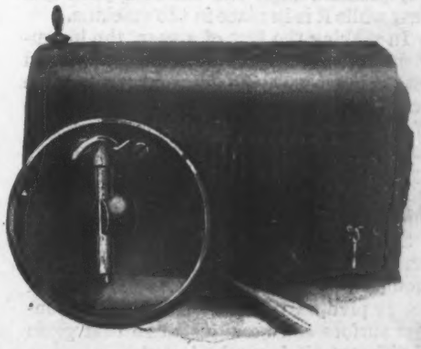
After the steam pressure has reached 750 pounds and the temperature 800 degrees, the blower motor circuit is opened by the control system. Fire ceases, the starting air tank is recharged for the next start and the steam in the boiler is sufficient to keep the car running. When the pressure runs down, the fuel is supplied automatically to the combustion chamber and ignited, but stops when enough steam has been generated.

The steam generator is a single tube 476 feet long, made up of 12 spirally wound coils of steel tubing, starting with a diameter of one half inch where the feed water enters, and increasing to 13/16 inch where the superheated steam leaves the generator. A novel feature is that of the combustion chamber, which is designed so that the fire does not strike the coils.

Power is provided by a four-cylinder double acting engine consisting of two 2½-inch high- and two 4½-inch low-pressure cylinders. The exhaust steam is condensed in a specially designed radiator and returned to the water tank. No cooling fan is required. Fuel under pressure is fed to a float chamber from a 25-gallon tank at the rear of the chassis.

Rubber Silencer Prevents Rattling of Hood

A NOVEL rubber silencer, said to eliminate all rattles in auto hoods, consists of a vacuum cup that grips the surface of a hood firmly, at the same time gripping the hood fastener by means of two cleats. The device thus prevents movement of the hood.



How the rubber silencer is adjusted

How I Made My Car Ferry Itself across Lake

By G. F. Korte

CAN you imagine a family marooned on a modern ranch?

That is exactly the plight in which my family and I found ourselves at Barrett, San Diego County, Calif., only a few months ago, because three miles of deep water at the front and the lofty mountains at the rear formed impassable barriers.

The city of San Diego had constructed a dam across the Cottonwood River about six miles below our ranch, and the resulting reservoir lake swelled by heavy storms, cut off our only road to the outer world.

Something had to be done. From stuff that was lying around the place I made a rude rowboat and oars, and rowed across the lake, where I was able to send out mail. But to get food and other supplies a long journey to the city was necessary. Even if I could reach the city on foot, neither I nor my rowboat would prove sufficient to carry back the things we needed.

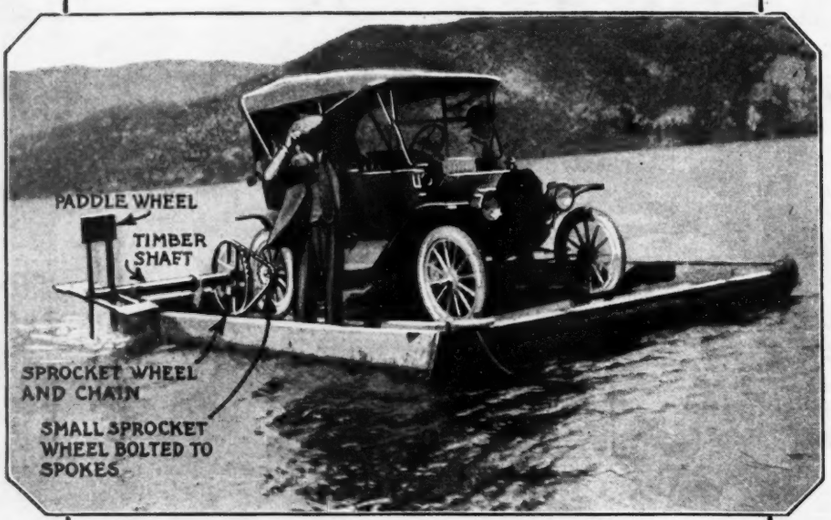
There seemed but one way out of the difficulty—to devise some way of getting my car across the lake. I decided that a flatboat offered the only solution.

I had no help and no materials. The floods, however, had strewn the lake with driftwood, and this I gathered, using my rowboat for the purpose. In a few weeks I was able to construct a scow, 12 by 15 feet, sufficient to support my Ford. At the beginning I had intended to try to paddle or sail the scow across the lake, but as it neared completion the thought occurred to me that it might be possible to supply motive power from the car's engine.

Accordingly, I rigged up a platform that permitted the rear wheels to revolve and geared one wheel to a shaft, which I made of a piece of four-by-four timber supported on wooden bearings. Then I built paddle wheels for the ends of the shaft, made a rudder of a 10-foot length of 12-inch plank and was ready to start.

My queer craft has been an entire success. With it I can make the three-mile journey across the lake in less than an hour. The car's motor has proved sufficient to drive the lighter across the lake, even when it is loaded with 1500 or 1600 pounds more than the weight of the car itself. I run at low gear, for a boat like mine is built more for cargo than for speed.

Except for the sprocket wheel and chain used to turn the shaft, which I retrieved from some old farm machinery, every part of the scow is constructed entirely of driftwood. I'm rather proud of my sturdy craft. It's seaworthy and reliable in calm or storm.



G. F. Korte and his auto-driven flatboat built of driftwood

How My Car Serves Me

A Prize Contest Announcement

AFTER you have read of Mr. Korte's ingenious use of his automobile, write and tell us about the unusual uses to which you put *your* car. What useful work does it do in addition to its regular duties in transportation? What led you to put your car to this novel service? What have been the results? Let your answer be based, not on theory, but upon actual experience.

You may have hit upon an idea from which we all can learn. For the best letter of not more than 400 words, accompanied by illustrative photographs or drawings, we offer these prizes: $20, first prize; $10, second prize; $5, third prize. Competition closes September 20. Winning letters will appear in the January issue.

Address Automobile Contest Editor, Popular Science Monthly, 225 West 39th St., New York City. Each letter will be considered by a board of editors whose decision will be final.

Contributions to this contest cannot be returned unless accompanied by a stamped, self-addressed envelope.

Gear Teeth Are Tested by New Instrument

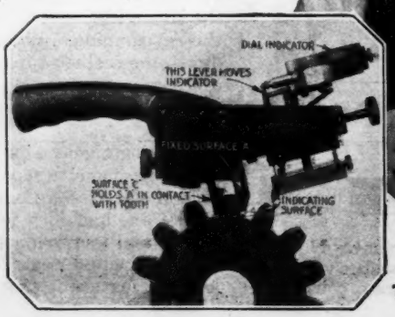
FOR accurately testing the uniformity of gear tooth profiles and the spacing of teeth in production work, an instrument has been invented which is easily operated and equally adaptable to spur and helical gears. It has a range of from three to 10 diametral pitch, may be used to check any pressure angle and can be applied to a gear while it is in place in the machine.

In making the test of a gear, the instrument is located over one tooth and rocked into contact with the adjacent tooth. One flank of the tooth rests against the surface of a fixed finger, marked "A" in the accompanying illustration, and is held in contact by the pressure of a movable member, "C," which is adjusted to the opposite flank of the same tooth.

The contact with the adjacent tooth is made by a movable indicating surface mounted on two thin, flat springs, which act as pivots without backlash. The contact surface can be adjusted so that gears of different pitch can be tested.

The dial indicator, which records any deviations in the profile or the spacing, is actuated by a lever connected with the indicating surface and is calibrated so that each division of the scale represents a movement of .0002 inch of the indicating surface.

Since the instrument tests the surfaces most essential for smooth and quiet operation, it is a simple matter to establish limits of tolerance for inspecting gears designed for any particular class of work.



Operation of the new apparatus in testing profiles and spacing of gear teeth is shown at the right. Note how dial indicator is operated by lever connected with the indicating surface

Testing gear teeth accuracy

Auto and Plane Take on Gas at High Speed

Non-Stop Refueling Proves Successful

ONLY the non-immortal tire now stands in the way of non-stop, long-distance motor journeys such as wheels never before achieved. No longer need automobile engines, capable of better than mile-a-minute speed and astounding endurance, halt unwinded in mid-course for oil, fuel, and water.

Fed with these necessities from a newly invented supply car while speeding at 50 miles an hour, a five-passenger touring car recently completed a record-breaking endurance run of 3155 miles in 50 hours and 21 minutes on the Indianapolis speedway. The average speed was 62.63 miles an hour.

Only Three Stops Made

The speed of the record-breaking auto was diminished only slightly as the supply car nosed up alongside, swung out a mechanical arm holding a flexible hose, and through it transferred fuel to the tanks of the racing car. The entire 3000-mile run was made with only three stops, all for tire changes. The engine went the distance without a break.

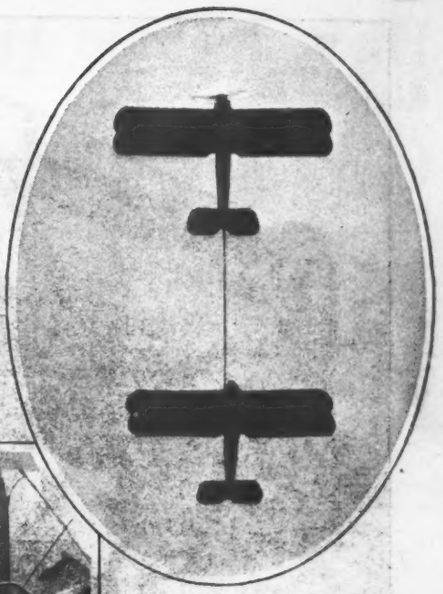
A. H. Means, head of the Contest Bureau of the American Automobile Association, commenting on this remarkable achievement, said: "The perfection of the supply car and its methods of transfer will greatly lengthen the distances between stops in long-distance engine tests on a speedway. Only the necessity for tire changing now stands between today's testing records and relatively indefinite non-stop runs."

A parallel achievement in the air was accomplished above San Diego, Calif., recently, when four army aviators successfully transferred gasoline from one plane to another while both machines were in full flight.

Rushing through the air at a speed of 90 miles an hour, the supply plane, manned by Lieuts. Virgil Hines and Frank Seifert, was guided to a position directly above a second plane flown by Capt. Lowell Smith and Lieut. John P. Richter. The men in the upper plane ran down a 48-foot steel-wire-incased rubber hose, through which the gasoline was transferred to the tanks of the lower plane. Only two minutes was required for the transfer of 50 gallons of gasoline in this manner. The transfer was made during an attempt of Captain Smith and Lieutenant Richter to set an endurance flight record by flying four days and four nights without stop.

Preliminary refueling tests developed one fault. That was the inability of the fueling plane pilots to haul the hose back into the fuselage. In one test Lieutenant Seifert was compelled to land with the 48-foot hose dangling under his machine. Finally, it was found that by enlarging the hole in the bottom of the fueling plane, the hose could be hauled aboard easily.

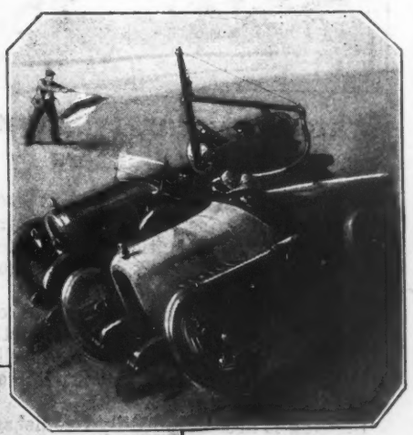
Lieuts. Frank Seifert (left) and Virgil Hines in the refueling plane from which they transferred 50 gallons of gasoline to the tanks of a plane flying below at 90 miles an hour. Note the 48-foot fuel hose, which was lowered as shown in the inset



Refueling in midair at 90 miles an hour

Since the wide roads of the air make high speeds safe, and since tire changes never fret the impatient aviator, this sky feat means that only the limited endurance of modern automotive power now prevents non-stop flights surpassing even the recent transcontinental flight of the two army aviators, Kelly and Macready. Planes now can be insured against running out of fuel or oil over long stretches that offer no landing facilities.

But tire changes still fetter the automobile. Perhaps a fifth wheel that will drop to the road and do duty for the one being changed, waits just around the corner of tomorrow's ingenuity.

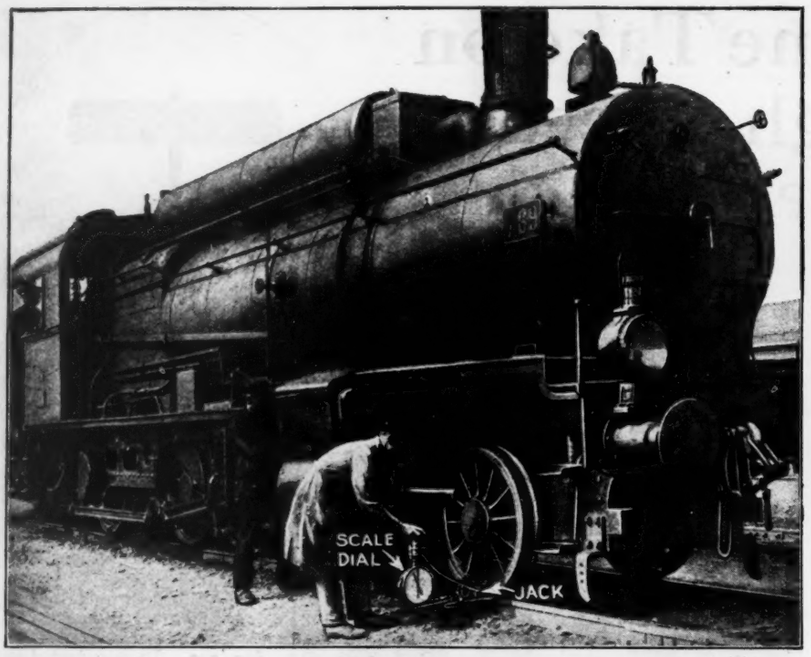


Transferring fuel, oil, and water while traveling at a speed of 50 miles an hour. Nosing alongside the racer, the supply car extends a mechanical arm holding a flexible hose through which fuel is delivered on the run

Diameters of Far Distant Stars Measured

BY THE invention of an instrument known as the "interferometer," Prof. Albert Michelson, of the University of Chicago, has made it possible for scientists to measure the diameters of far distant stars which, even to the most powerful telescopes, appear as mere pinpoints of light. Two mirrors attached to a slide on this instrument, which is 20 feet long, reflect beams of light from the star back and forth until they are finally directed against the mirror of a giant telescope that magnifies them many thousand of diameters.

The light from the star, as reflected by the mirrors of the interferometer, is broken up into its spectrum, and the mirrors are moved about until the two spectra coincide. When this happens, triangulation is used to obtain the diameter of the star. The distance between the two mirrors, known length of light waves, and the previously determined distance of the star from the earth supply the data for the astronomers' calculations.



Portable "Jack" Scale Weighs a Locomotive

HOURS of time may be saved the shipper by a new portable weighing machine, shown above weighing a locomotive, which makes it possible to weigh carloads after they have been put in the car.

The machine acts on the same principle as the ordinary "jack." It is put under the wheels of the car, one wheel at a time, and the grand total computed from the four weights as recorded on the scale dial.

Wagons and trucks also may be weighed by this device.

New Open Fire Grate Burns Its Own Smoke

TO DO away with the disadvantages of open fireplaces, measured by housewives in terms of sooty curtains and darkened wallpaper, an English inventor has perfected a coal fire grate which, he claims, consumes its own smoke.

The grate is fed from the top. By means of a device that causes the smoke to be mixed with the gases from the burning coal, the smoke is consumed before it has a chance to escape into the room.

Experts estimate that only about 20 per cent of the heat from coal burned in an ordinary open grate is effective in warming a room. With the new invention, the proportion of efficiency is said to be large.

Feeding the grate from the top

Water Bicycling Is Latest Sport for Bathers

BICYCLING in the water is the newest sport at the fashionable seashore resorts along the Atlantic Coast, where bathers ride an odd craft imported from England.

In the water, the craft is submerged, except for air tanks fore and aft. Pushing the pedals operates a three-bladed propeller that carries a guard to prevent it from being fouled by seaweed.

Steering is accomplished by handlebars, which in this case turn a rudder instead of a front wheel.

The sport is safe, even if the craft happens to be upset by waves, for the air tanks supply a never-failing life raft.

IN AN early issue, Dr. Minna C. Denton, assistant chief of the United States Office of Home Economics, will tell how to save from 25 to 50 per cent on your household gas bills.

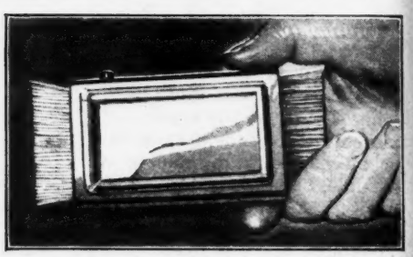
Old Razor Blades Turned into Handy Scraper

ONE of the most valuable uses yet devised for old, discarded safety razor blades is that of a scraper for removing paint or varnish in any job of refinishing.

For this purpose the handy razor blade holder shown in the illustration has been invented, and now is being manufactured. The razor blade is inserted in a metal clamp and fastened securely by means of a thumbscrew. A comfortable grip for the fingers is provided.

The keen cutting edge also may be used in scraping and smoothing woodwork.

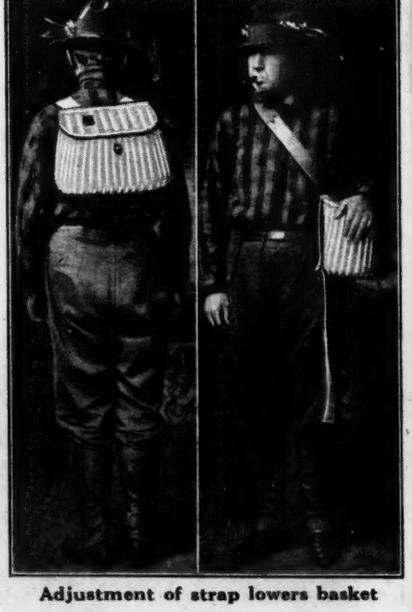
Pocket Toilet Outfit Has Disappearing Brushes



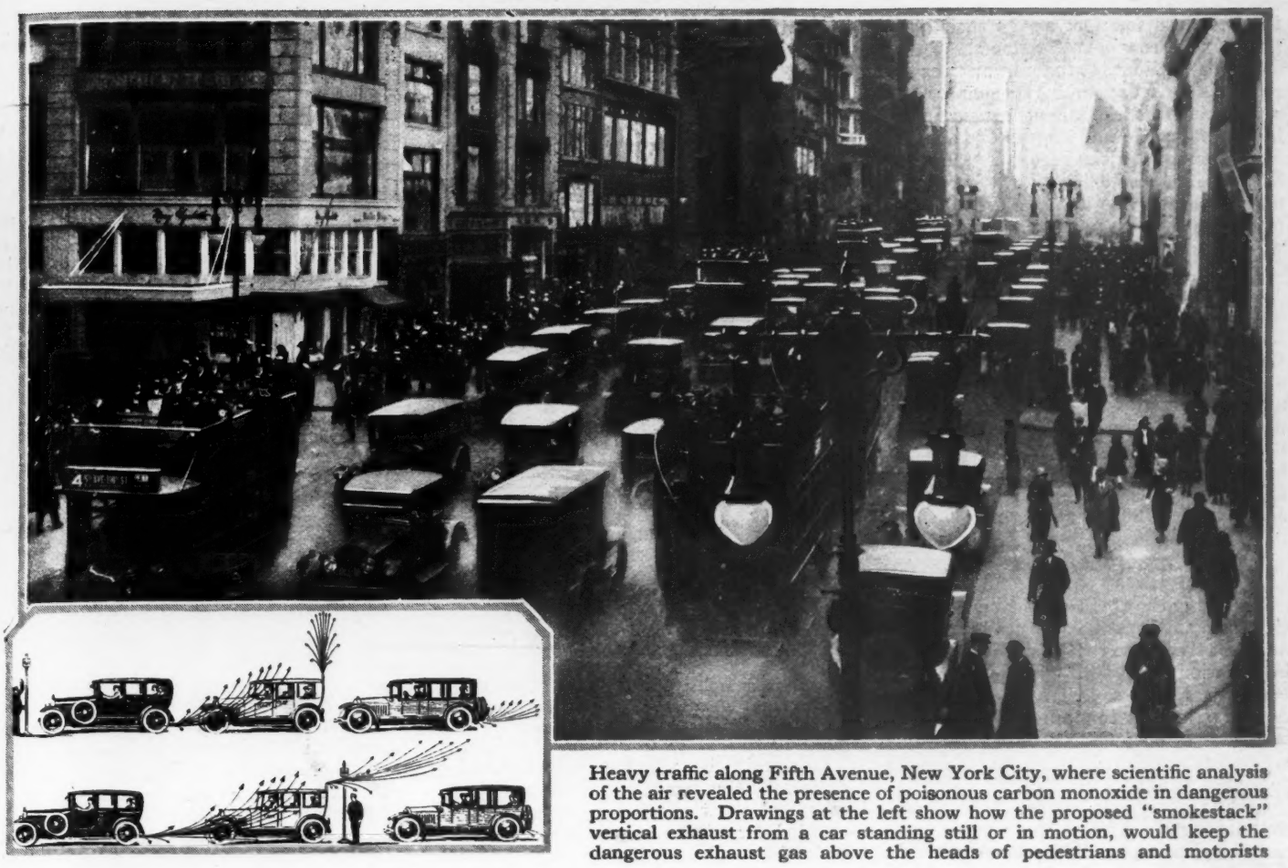
DESIGNED especially for use in traveling, a novel combination toilet outfit includes two disappearing clothes brushes, a mirror, comb, and manicure stick. It can be carried in a woman's shopping bag.

Ingenious Creel Strap Is Quickly Adjusted

ON THE knapsack principle, an Idaho inventor has designed the fisherman's creel strap shown below. When not needed, the fishing basket may be slung on the back. A simple adjustment of the strap permits the basket to be lowered instantly.



Adjustment of strap lowers basket



Heavy traffic along Fifth Avenue, New York City, where scientific analysis of the air revealed the presence of poisonous carbon monoxide in dangerous proportions. Drawings at the left show how the proposed "smokestack" vertical exhaust from a car standing still or in motion, would keep the dangerous exhaust gas above the heads of pedestrians and motorists

Exhaust Auto Gas, a Lurking Assassin

How Scientists Fight Odorless, Tasteless and Colorless Carbon Monoxide, a Growing National Peril

By Raymond J. Brown

"IF THE entire population of a city were to breathe air containing two parts of carbon monoxide to 10,000 parts of air continuously night and day, a large proportion of the population would be incapacitated for work. Many with weak hearts would die."

To every city dweller and city worker, this recent statement of Professor Yandell Henderson, of Yale University, in a report to the New York Academy of Medicine, comes as a danger signal, warning of an increasing traffic menace to human health and even to life itself. For it merely supplements a more startling assertion by Prof. Henderson, which is this:

On every street in America where motor traffic is heavy, carbon monoxide is present in more deadly proportions even than those listed as dangerous to life and health!

From the exhaust of every gasoline driven automobile, motor truck and taxicab, clouds of this poisonous gas are poured every minute into the atmosphere above city pavements. It is a gas more dangerous, according to Professor Henderson, than the smoke rising from the chimneys of dwellings and factories or from the funnels of locomotives. It is the very same gas that frequently causes the death of miners; the same gas which has killed many persons who have allowed their automobile engines to run in closed garages.

Professor Henderson bases his amazing statements on the result of scientific tests which he recently conducted on Fifth Avenue, New York City, in collaboration with Dr. Howard W. Haggard, of the Yale University laboratory of applied physiology. And, since every city has its Fifth Avenue—a thoroughfare through which an enormous amount of motor traffic pours each day—his findings apply to great centers of population throughout the country.

One type of auto exhaust "chimney" proposed by Professor Henderson, to carry gases upward without spoiling the car's appearance or performance

That this dangerous situation has not already produced serious results, Professor Henderson attributes to the fact that the millions who breathe the poisoned air of city streets usually do so only for a few hours each day. The practically pure air which they breathe at night acts as an antidote for the poison gas. Even now, Professor Henderson asserts, thousands of people whose business takes them to streets where motor traffic is heavy are unknowingly suffering every day from carbon monoxide poisoning in a slight degree. The immediate effects are headaches, lassitude, and, in some cases, extreme dizziness and violent nausea. The lasting effects are extreme nervousness, irritability, and lack of energy. Anemia and a proneness to tubercular infection may follow long-continued subjection to the gas.

The menace of carbon monoxide is all the more deadly because of the insidious method of its attack. It is colorless, odorless, tasteless, invisible. In consequence it may be breathed in quantities sufficient to cause permanent injury, or even death, before the victim is aware of its presence in the atmosphere. A few inhalations; then come sudden dizziness, acute nausea, muscular weakness. The victim falls, and, unless he is removed instantly from the poison-laden atmosphere, he is likely to die. Only a few seconds intervene between the first realization of danger and death, a fact which is proved by the number of persons who, realizing their peril, have been unable

to struggle a few feet across their garage floors and throw open the doors.

The attention of the nation was first called to this danger in December, 1917, when Nat Wills, the famous comedian, died in this way. He had started the engine of his automobile in the garage at the rear of his home in Woodcliff, N. J., to "warm it up" preparatory to taking a drive and was overcome by carbon monoxide. He died while trying to reach the door.

Death, of course, comes only in extreme cases, when the amount of carbon monoxide inhaled is large. When the gas is present in the air in smaller quantities—say about three parts of carbon monoxide to 10,000 of air—the effect on those who breathe it may be compared to that which would be produced on anyone suddenly transported from sea level to one of the highest peaks of the Andes—dizziness, nausea, lassitude and headaches lasting 20 hours or more.

Drivers Are Affected

Breathing the gas in a large quantity for a short period will produce an effect similar to that of alcoholic intoxication. In this connection, Professor Henderson declares that drivers on city streets are likely to be rendered incapable of properly operating their vehicles by carbon monoxide poisoning at almost any time.

Carbon monoxide attacks the hemoglobin, the red coloring matter and oxygen-carrying element of the blood, and prevents it from carrying oxygen from the lungs to the body tissues. The carbon monoxide replaces, part for part, the oxygen which the hemoglobin is carrying—a fact that explains how the danger from inhaling it increases in proportion to the amount taken into the lungs.

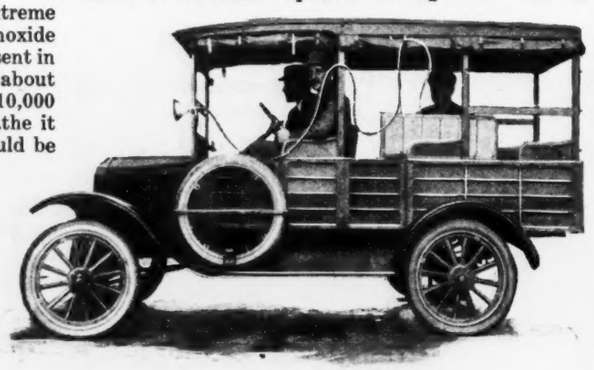
Traffic police on duty on streets where motor traffic is especially heavy frequently have complained of dizziness, headaches and lassitude at the end of their day's work. They have believed this to be due to greater physical and mental strain when directing huge streams of traffic than when performing other duties. Motor bus and taxicab drivers in crowded streets also have believed that the worn out feeling which oppresses them at the end of the day is due to the strain of constantly stopping, starting, and turning aside to avoid collision with other cars in heavy traffic. Yet science now tells us that they are suffering from carbon monoxide poisoning.

Garagemen Suffer Depression

Employees of public garages and repair stations where automobile engines often are permitted to run for long periods suffer similar depression.

Professor Henderson and his associates were informed by the managers of several repair stations that their men frequently have to quit work and rest because of inexplainable headaches and weakness, which the investigators assert undoubtedly are due to carbon monoxide poisoning. In one large shop where Professor Henderson inquired how many of the men went home each day with headaches, the answer was, "Nearly all of them nearly every day."

Science already has begun the search for a means of eliminating this newly found sneakthief of the nation's health. Professor Henderson himself has suggested as a remedy, that all automobiles should be compelled to carry chimneys, opening above the highest point of their bodies. This would throw the deadly poison of their exhausts into the air, far above the nostrils of pedestrians and motorists. The prevailing car construction which places the exhaust below the body, he says, is unscientific and unsuited to present conditions. No danger will come to persons in the upper stories of buildings by this revolutionary method of exhaust, he adds, since science has demonstrated that the air within a building tends to circulate upward through the



In this car, equipped with apparatus for obtaining instantaneous air samples, Prof. Yandell Henderson made the tests which revealed the peril of carbon monoxide

building, rather than in from the windows.

Other scientists who have been stirred by Professor Henderson's revelations have suggested great ventilating fans to carry polluted air of the streets far above the roofs of even the tallest skyscrapers. Ventilating engineers and sanitary authorities generally are turning their ingenuity to a solution of the problem.

The investigations undertaken by Professor Henderson and Dr. Haggard were the first of their kind. To determine scientifically the exact amount of carbon monoxide diffused through a street where motor cars pass, a small car was equipped with sampling cans, bags and bottles. The cans, filled with water, were connected by a pipe

Taking the blood from a miner for a test to determine the presence of carbon monoxide poison. The gas replaces the oxygen supply carried by the hemoglobin of the blood

with a funnel on the windshield, and, as the water flowed out of the cans, air was drawn in. These samples of air were preserved and analyzed in the laboratory, samples being taken in traffic of varying density.

The investigators knew at the outset that the amount of smoke issuing from a motor exhaust has no connection with the amount of carbon monoxide given off, for it had been determined by the United States Bureau of Mines that smoke and smell are due to excess oil, while the carbon monoxide is developed only by the combustion of the gasoline.

Observations were made of cars standing still with their motors idling, and cars in motion. In the case of a car standing still, it was shown that the vapors from the exhaust spread in a cone, so that a man standing a few feet back of the car is surrounded by an atmosphere containing four to six parts of carbon monoxide to 10,000 parts of air—a dangerous proportion—while the occupants of another automobile 30 feet in the rear would be breathing two parts of carbon monoxide to 10,000 parts of air. When a car is in motion the cone of diffusion is elongated. In damp, still weather the proportion of carbon monoxide to air is considerably increased.

Benzol Increases Gas

The investigations also developed the fact that fluids frequently mixed with gasoline to increase its power or combustibility — particularly benzol—cause an increase in the amount of carbon monoxide in the city streets.

In his report to the Academy of Medicine, after noting the fact that a dangerous percentage of carbon monoxide in the air is no unusual condition in a thoroughfare having heavy motor traffic, Professor Henderson said:

"It is a surprising fact that in spite of modern scientific knowledge and the extensive legal protection now afforded public health, automobiles are almost always built so as to discharge their exhaust gas near the ground, instead of vertically upward as all other smoke and noxious vapors are delivered. If the exhaust gas of automobiles constantly contained soot particles, or what we term smoke, there never would have been any question that the automobile engine should be provided with a chimney.

"Fortunately, we have been able to observe the working of the vertical exhaust, for in some cities it is already customary for bakery wagons to be fitted with such a pipe to protect their cargoes. No appreciable loss of power results. The gas thus delivered, being warm, continues to rise. While it is rising, cool fresh air blows down along the walls of the buildings, tending to prevent the gas from entering windows."

Valuable Experiments in Mines

In mines, too, extensive research work in the campaign against carbon monoxide gas has been carried on. Dr. R. R. Sayers, chief surgeon of the United States Bureau of Mines, and W. P. Yant, a chemist of the Pittsburg experiment station of the bureau, have devised a new method to determine the presence and extent of carbon monoxide poisoning. They have invented an apparatus for testing blood of victims and by their method the presence of the poison is established in three minutes and its extent within 15 instead of 24 to 48 hours as formerly.

Dr. Hubert Work, Secretary of the Interior, and a former president of the American Medical Association, has predicted that the apparatus soon will be in universal use by physicians. He bases his prediction on the growing menace of carbon monoxide in the streets as well as its presence in mines and industrial plants.

But this is just the starting point in the scientific war against this new danger to national health—a danger that demands immediate solution by the nation's scientists and by officials of our cities.

Pontoons Raise Wreck from Sea

POWER HOUSE
LIGHTER
COMPRESSED AIR
COMPRESSED AIR PONTOONS
PONTOON HOOKED INTO SHIP HERE
ELECTRIC POWER CABLE TO TRACTOR
SUBMARINE TRACTOR SUBMERGES TO GREAT DEPTHS, BORES HOLES IN SIDES OF SHIP AND INSERTS HOOKS ATTACHED TO PONTOONS

AN improved method of salvaging sunken ships was demonstrated successfully off Whitestone, Long Island, recently when the wrecked coastguard cutter *Scally* was raised by compressed air pontoons.

This new system consists of two working units—a submarine tractor driven by electric motor, and open-bottom, submersible pontoons. The tractor is lowered from a lighter to the ocean bottom, where it travels on endless treads like a huge crab.

The body of the tractor is a "diving" chamber (at the right), large enough to hold two men. In it are fixed two steel drills which bore five inch holes into the sides of the sunken vessel.

The pontoons then are drawn down and attached to the wreck by hooks inserted in the bored holes. Their buoyancy is sufficient to enable an electric motor to raise the wreck

The Science of Fire Fighting

Prevention of Disaster Is First Aim of Modern "Smoke Eaters" Who Battle with Flames and Risk Lives in Thrilling Rescues

As Told by Chief John Kenlon *of the New York City Fire Department*

MODERN fire fighting is a scientific profession. It may be compared with the profession of medicine. All fires have common characteristics that enable a fire department officer to use certain clearly defined principles in coping with them, just as a doctor, through his knowledge of disease symptoms and effects, is able to effect cures for individual patients.

To-day the analogy between the profession of fire fighting and the profession of medicine never was more apparent. Modern medical men seek to control disease by striking at its root, eliminating its causes, rather than by curing their patients after they have become sick. Just so the modern fire fighter endeavors to prevent fires before they have broken out, rather than to attack them after they have started.

A Frightful Danger

Yet in this effort he is hampered by an amazing public apathy to the ever-present and frightful danger of fire. About 15,000 persons die from fire in this country every year. Last year, according to recently announced statistics of the National Board of Fire Underwriters, the total fire loss—fire waste, I might say—in the United States was $521,860,000.

No other nation in the world approached this figure. The per capita fire loss in the United States was the greatest in the world—$4.75, as compared with 72 cents in Great Britain.

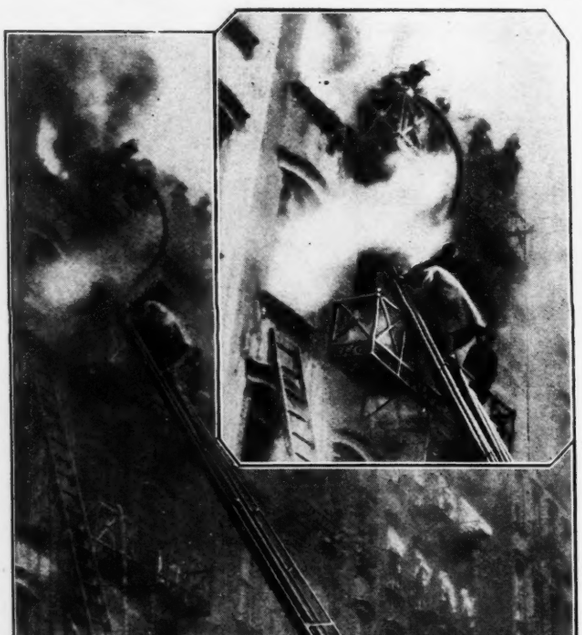
Now, there is no doubt that America leads the world in the development of scientific fire fighting apparatus. The American municipal fire departments are as well-drilled and as efficient as those of any other nation. Why, then, the appalling difference between our fire loss and the loss suffered by other nations?

Carelessness Chief Cause

Of several contributing causes, the principal one is carelessness. This statement, I believe, is amply borne out by the fact that 65 per cent of the fires in the United States occur in dwelling houses. People are habitually more careless at home than in their shops and offices, although carelessness also plays its part in causing fires in other places besides the home. In industrial plants and office buildings carelessness—usually with matches and lighted cigars and cigarettes—almost invariably takes precedence over defective electric wiring, explosions, back-fires from internal combustion engines and other causes of a more or less accidental nature.

It was a careless smoker who caused the terrible Asch Building fire in New York City in March, 1911, in which 145 girl employees of the Triangle Shirt Waist Company were burned to death. Carelessness also may be blamed for the loss of more than 600 lives in the Iroquois Theater fire in Chicago, the most frightful theater fire the country ever has known.

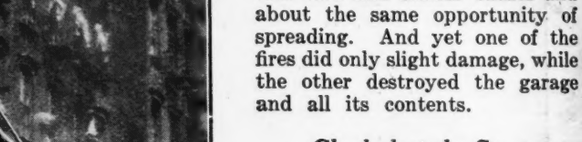
In preventing catastrophes such as these, probably the most effective weapon devised by science is the sprinkler system, which sprays water from a central water plant automatically as soon as the heat in a building rises to a certain point—usually about 155 degrees.



The New and the Old Way in Fire Fighting

ABOVE is a remarkable photograph of a recent thrilling rescue from a burning East Side tenement. The inset shows Fireman John A. Johnson carrying a tenant through smoke and flames down the aerial ladder with which the modern hook and ladder truck is equipped.

At the right is one of the antiquated fire carts which attempted to fight the flames that destroyed the City of Smyrna a year ago



Automatic Protection

Installation of scientific sprinkler equipment assures almost absolute protection against fire for industrial plants, hotels, office buildings, public meeting places, warehouses and similar structures. Its efficiency has been demonstrated time and time again. It holds a fire in check until the fire department arrives and it also automatically sounds the fire alarm.

Two garages caught fire in the same New England city one night about a year ago. The buildings were of the same size and each contained about 50 automobiles. The fires had similar causes and about the same opportunity of spreading. And yet one of the fires did only slight damage, while the other destroyed the garage and all its contents.

Checked at the Start

A sprinkler in the first building checked the fire until the fire department arrived to quench it entirely. In the second building the absence of a sprinkler system permitted the fire to gain so much headway that it was impossible to prevent the destruction of the building and the automobiles within it.

Yet with incidents of this sort occurring almost every day, owners of buildings which should be protected by sprinklers are slow to install them. Strange as it may seem, I believe that many owners of large buildings never have heard

Fighting a stubborn blaze in downtown New York. Note the water tower apparatus that raises hose line 10 stories above the street. At the right, a fireman protected by gas mask is shown rescuing a comrade overcome by gas while fighting a suffocating sub-cellar fire

of sprinkler systems. Others, who know about them, have failed to install them, preferring to take a chance on a fire breaking out.

Automatic fire doors, which, operated by thermostats, close when the heat rises, thereby shutting off the draft which would cause the fire to spread, are another form of fire protection which science has furnished, as are chemical fire extinguishers.

Few dwelling houses contain fire extinguishers. Every home should have at least one, and every member of the family should be instructed in its use.

In the ideal dwelling house the first floor at least should be fire-proof, but since we have not yet reached the millennium, that, of course, is not now the rule. People can, however, endeavor to make their dwellings as nearly fire-proof as possible. They can prevent inflammable rubbish from accumulating. If they use gas light, they can see that the flames are surrounded by proper guards. They can see to it that every match they use is entirely extinguished before they throw it away. They can prevent window draperies from being blown against gas jets. They can keep matches out of the hands of children and they can store matches where rats cannot gnaw them.

I said at the outset that all fires possessed points of similarity which permitted fire departments to use general principles in combatting them. Briefly, these broad principles are:

The outbreak must be confined to as narrow a space as possible.

Contiguous property must be protected by every means available.

Injury and loss of life must be prevented.

Efforts must be made to centralize the outbreak as a whole.

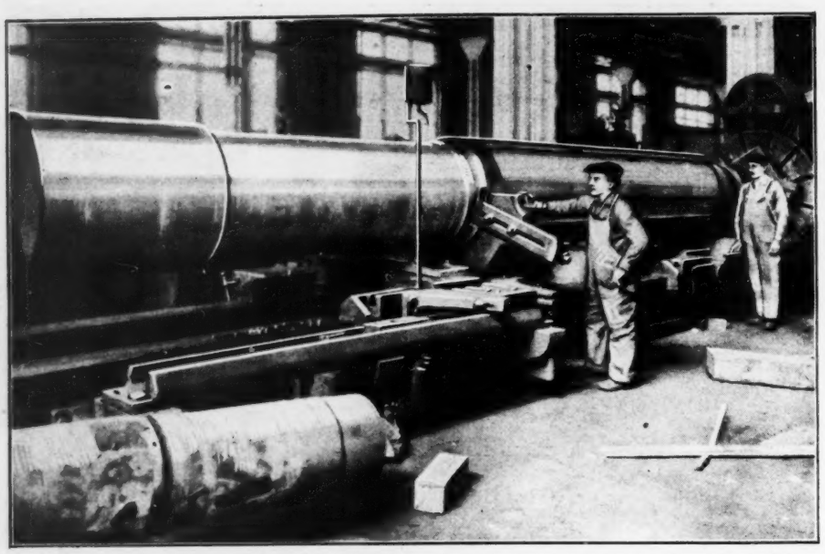
All forces must be concentrated on the point of greatest danger.

As in the movements of troops in war, firemen endeavor to outflank the fire. Certainty and rapidity in their movements are necessary to success, for fire is a dangerous enemy which takes no prisoners and uses every mistake of its foe to its own advantage. Fire also may be said to keep abreast of the times. The very development of the automobile and the gasoline engine, which has given us motor-driven fire-fighting apparatus, at the same time has supplied fire with new ways of spreading havoc. At the very time when new rules and devices made theaters more safe from fire hazards, came the highly inflammable celluloid moving picture film, a new ally of fire in its fierce warfare against man and his property. As an indication of just how dangerous a menace celluloid film is, France has just passed a law making the possession or use of any but non-inflammable film a penal offence after March, 1925.

Chemicals, whether in great chemical manufacturing plants, in corner drug stores, or in storage, are a frequent cause of accidental fires, difficult and dangerous to control. Not long ago a large warehouse in Jane

(*Turn to page 96*)

The heart of the scientific fire system at the national capital. Here each alarm is recorded. Simultaneously it is sounded in every firehouse in the District of Columbia. Note the elaborate automatic signalling and recording mechanism



Forty-Ton Shaft Tooled to a Hair's Breadth

A REMARKABLE feat in precise machine work on an enormous scale was accomplished in the shops of the General Electric Company at Schenectady, N. Y., when the 40-ton steel shaft shown here was tooled down on a giant lathe to the exact size necessary. It will be the main shaft of two motors, each capable of developing 3250 horsepower. An error in cutting of more than one one-thousandth of an inch would have rendered the shaft useless, but the work was completed successfully.

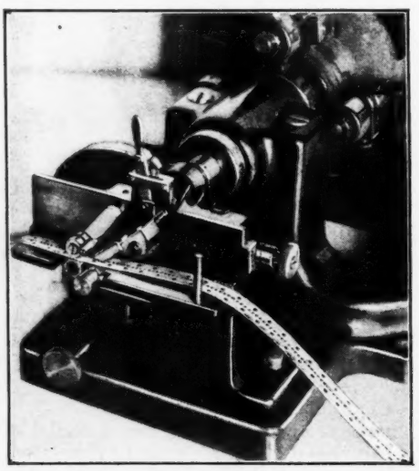
High Speed Telegraph Code Invented by General

THAT the Morse telegraph code, invented 80 years ago and used with scarcely any modification ever since, is fundamentally unscientific and unsuited to the new developments in telegraphy, particularly in radio, is the belief of General George O. Squier, chief signal officer of the United States Army. As a result, he has devised a new code, which has demonstrated its effectiveness.

General Squier has endeavored to adapt to telegraphy the modulation of telephony and music. Using the familiar dots and dashes of the Morse code as a basis, he has invented a system of transmission in which, by making all signals of the same length, he obtains an increase in sending speed 165 per cent greater than that of the Morse code and an accuracy in reception never before attained. The system minimizes the likelihood of interference in radio messages and lessens violent disturbances in the ether which hamper radio transmission.

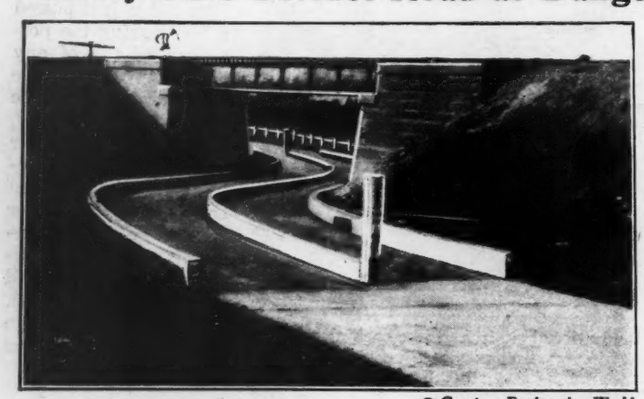
Instead of producing signals by alternately turning on and shutting off a flow of electric current, General Squier causes an alternating current to flow from his transmitter uninterrupted, distinguishing his signals by varying the intensity of the individual elements—the dot, the dash and the space. It is like signalling with a single continued musical tone. A faint sound would represent a dot, a louder sound a dash, and a still louder one a space, each signal occupying the same length of time.

The Squier code may be sent automatically by a transmitter of the type shown.



Transmitting the new code automatically

Safety Curb Divides Road at Dangerous Curve



© Courtesy Engineering World

AN INNOVATION in highway safeguards is a center curb at a dangerous turn in a road under a Southern-Pacific railway bridge at Weimar, Texas.

The middle curb, eight inches high, divides the roadway into two lanes, each 10 feet wide. An eight inch concrete post at each end warns the motorists to "Keep to the Right."

Non-Drip Coffee Strainer Protects Table Linen

HOUSEWIVES who are continually scrubbing out stains caused by tea or coffee while it is being strained will welcome the new non-drip strainer recently invented.

This new strainer is equipped with a small basin slung underneath. When strainer is in use, the basin is pushed aside. Afterward it moves back into position beneath the seive, where it catches the drops that otherwise would land on the tablecloth and stain it.

Novel Door Guard Protects Housewife from Intruders

A PROTECTION for the housewife who is timid about answering door calls is furnished by the door guard that grips the floor, as shown below. It may be pushed into place or released by a movement of the foot. When in place, an intruder cannot possibly open the door beyond the point at which the guard holds it, unless he smashes the panels.

The device consists of a bracket which is attached to the door, a lever and a rubber shoe that grips the floor. The latter is described by its inventor as "100 per cent non-skid." Unlike chain bolts, this device permits the door to be opened as far as the person within the house desires.

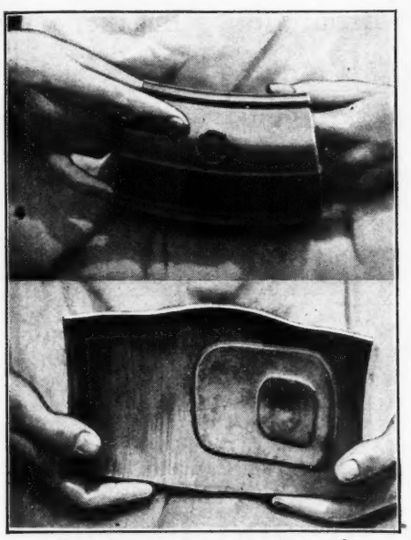
The lock can be attached easily and is manufactured in various sizes so that it can be used on practically any door.

This secure door guard can be snapped into position by the foot

New Cold Patch Repairs Cuts and Blowouts

ANY motorist can be his own tire repairman, and can successfully mend punctures and blowouts by using a new cold patching material, which is so compounded that heat will not cause it to loosen or weaken. The material comes in a sheet and is made of specially treated rubber reinforced by a special fabric. A patch is applied with a cold cement in the usual way.

Blowouts, cuts and sand blisters in casings are repaired according to approved tire repair methods, but no heat is used. In the case of a blowout, a piece of repair material is cut so that its edges overlap the hole by one half inch and is cemented in place. Another piece is cut to overlap the first piece one half inch all around, and is cemented on. One piece is added for each inch in tire section. A three-inch tire requires a three-layer patch and a five-inch tire a five-layer patch.



Exterior and interior views of cold patch applied to a tire hole

Motorized Prune Picker Does Work of 10 Men

A MOTORIZED prune picker with which one man can do the work of seven to 10 has made its appearance in the Santa Clara Valley, California, where 65,000 acres of prunes are harvested each year.

A metal roller, operated by a one-horsepower gasoline motor, carries the machine from place to place. The engine likewise operates a drum covered with steel pins that pick up the prunes from the ground as the drum rotates and deposits them on an elevator. There they are carried to a box above.

Control of the roller and drum is from a handle resembling that of the ordinary lawnmower. The operator steers the device to any desired spot.

One man, working by hand, can gather about a ton of prunes a day, while the machine can pick between seven and ten tons in the same time.

Chlorine Gas Prevents "Flu"

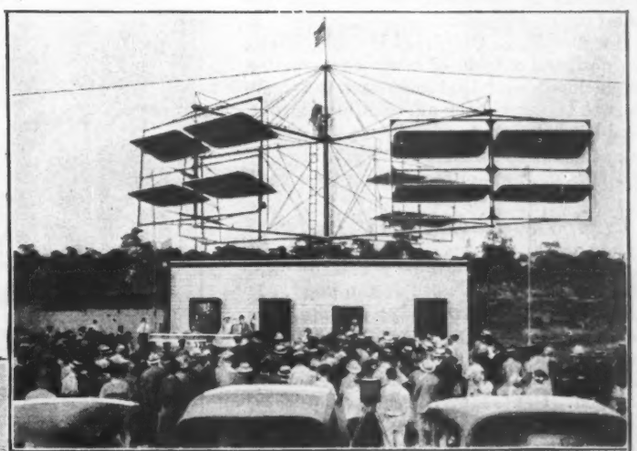
CHLORINE gas, used as a war weapon, now is being turned against the germs of influenza and is proving effective in preventing the disease. In experiments with students at the University of Arkansas, conducted by Professor Harrison Hale, during a recent "flu" epidemic, the gas treatment reduced the sick rate 90 per cent. The gas was breathed in very dilute quantity, preventing poisonous effects.

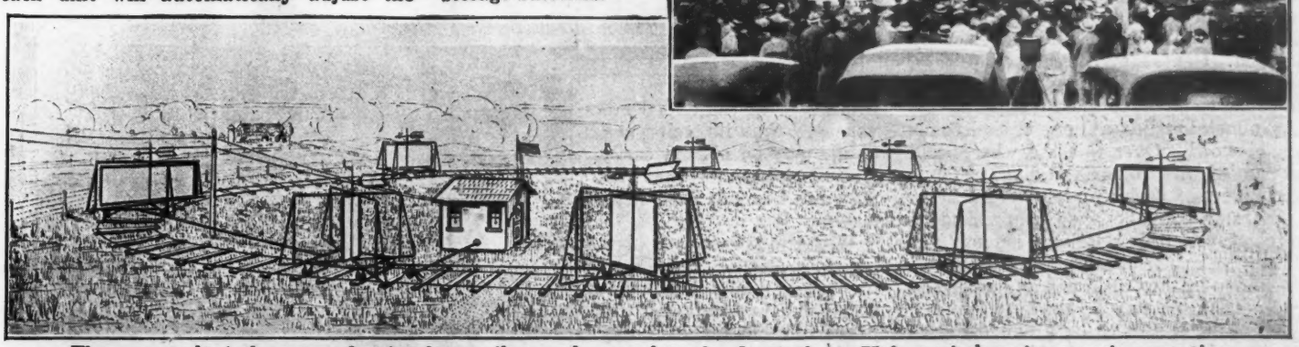
Giant Merry-Go-Round Wind Motor to Harness Breezes

HARNESSING the wind for mechanical and electrical power by means of a windmill a mile in circumference is the amazing project being worked out by a company organized by a Florida inventor. Experiments conducted with model 75-foot windmotors are said to have demonstrated the enterprise to be entirely feasible.

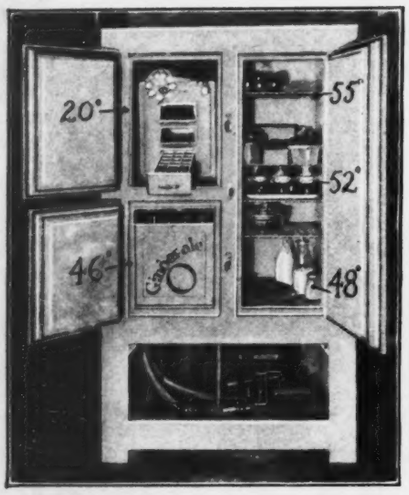
The proposed giant windmotor will run on a circular, double-rail track to be laid on the ground. It will have 36 sails, each 12 by 25 feet square and mounted on a separate truck. An elaborate gearing system on each unit will automatically adjust the angle of the sails to take full advantage of the direction of the wind and also lessen the sail resistance when traveling against the wind.

The wind motor will be connected with an electric dynamo and the current generated will be held for use in storage batteries.

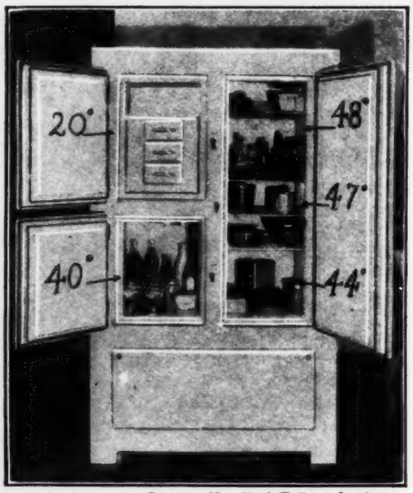




The proposed wind motor, showing how sails travel around track. Inset shows 75-foot wind engine now in operation



The wrong way to fill an icebox



Courtesy New York Tribune Institute

The right way—lower temperatures

Filling an Ice Box Scientifically

THE two photographs above demonstrate, according to the New York Tribune Institute, the right and wrong ways of filling an ice-box.

The icebox in the illustration at the left is "stuffed;" that is, the food is packed in a haphazard manner which crams the compartments, stops the circulation of air and prevents the refrigerating chamber from extracting the heat from the other sections of the box.

The same icebox is shown packed scientifically in the illustration at the right. The food is arranged in the compartments in an orderly and systematic manner, permitting circulation; and with . .e different foods in the proper compartments. Note the corresponding decreases in temperature in the compartments, indicated in degrees.

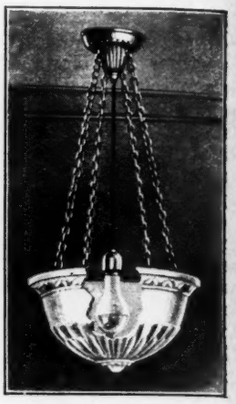
This icebox is supplied with mechanical refrigeration, but the same principles regarding the storage of various kinds of food are said to apply to any ice box. The comparative figures on the insides of the doors show in degrees F. which parts of your icebox are coldest, and will furnish a guide for you in storing food, since you know from its character whether it requires very low or higher temperatures for preservation.

Fortunes in Alaska Foxes

FOX raising on a large scale has been developed in Southeastern Alaska during the last year, according to reports of the Interior Department. Many farmers have taken up the raising of blue and silver foxes. Small islands along the coast, useless for other purposes, have been turned into fox farms.

Light Bulb Shield Cuts out Wall Shadows

THE glass shield on the upper part of the electric light bulb shown here prevents the light from causing the chains which support the fixture to cast shadows on the ceiling. A special kind of glass developed by a Pittsburgh manufacturer is used in the shield to filter out objectionable shadows.



The shielded bulb

Shield Protects Door Lock from House Breakers

THIS novel shield prevents a housebreaker from opening a lock by shattering the glass and thrusting his hand through the opening. The lock is covered completely. Its bolt engages the shield as well as the socket in the door frame, making it impossible to unlock without a key.

Closed Auto Body Made of Chicken Wire and Fabric

MANY a motorist prefers a car with a closed body, yet does without it because of the additional expense involved, or because he fears that neither his skill nor equipment is sufficient to construct the metal panels himself.

But now K. L. Childs, of Detroit, Mich., has designed a type of body construction for enclosed cars that offers many attractions to the ambitious and skilful amateur. His idea is being developed commercially, but it may be used effectively also by amateurs desirous of remodeling their cars.

Originality of Color and Design

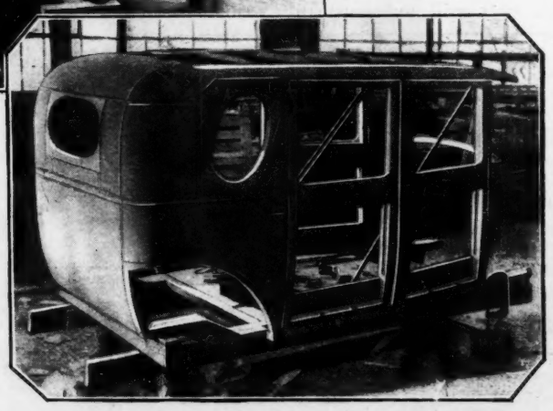
Fabric laid over ordinary chicken wire furnishes the groundwork of the body. It is lighter than a metal body; it minimizes the painting problem, because the fabric is already colored and enameled before use; it is more easily repaired and is not so easily damaged. Dents may be removed quickly, and the body is not subject to the noises and rattle common to most metal bodies.

As in metal bodies, a frame or skeleton is built of wood. Over this the wire is laid and padded with cotton wadding, which is held in place by tacking a layer of buckram to the frame. The body is then finished by stretching over this relatively smooth but soft surface a special fabric, such as imitation landau leather, although any enameled or painted fabric may be used.

The result is said to be a closed car as attractive in appearance as the most expensive, with the added advantages that its color and design may be altered easily and cheaply, and that repairs can be made with little trouble.

With the growing popularity of the closed car, the need for just such a body that can be built economically yet will prove durable for everyday use has long been apparent.

At the left, the wooden skeleton of the closed car body, showing how chicken wire reinforcement is placed over the wooden frame



Below, the body nearing completion. The wire is padded with cotton wadding held in place by buckram. Over this, a special fabric is stretched tightly

Will the Sun Ever Fail Us?

By Robert E. Martin

NEXT to creation itself, the sun always has remained for mankind the supreme mystery of the universe. Now we are on the threshold of an event to which astronomers everywhere are looking forward eagerly as an opportunity to leap across the barrier of distance which separates them from complete understanding of this source of heat and light.

It is the eclipse of September 10, when the sun will be obscured by the shadow of the moon falling between it and the earth. An eclipse, which shrouds the glare of the sun's center, gives the astronomer a peculiarly fruitful opportunity of studying the outer layers of the sun, particularly the corona, the uppermost stratum of its atmosphere.

Reports Sun Is Cooling Off

Will the coming eclipse reveal some new chemical element in the sun's composition, some substance not yet found upon earth? Will astronomers find the answer to the question whether the interior of the sun is solid or gaseous? Will they learn the source of its tremendous, seemingly inexhaustible energy?

In the opinion of some scientists, astronomical observation of that day even may furnish support to the recent startling suggestion that the sun is failing us!

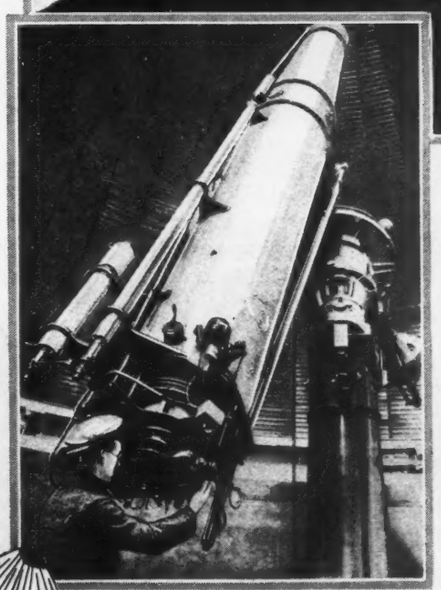
Not long ago Dr. C. G. Abbot of the Smithsonian Institution announced that the heat of the sun had fallen off 3 to 4 per cent in the last year or so. His announcement was the result of observations made at the Smithsonian Institution's stations in Arizona and Chile, where accurate measurement and tabulation of the intensity of solar energy has been carried on for 20 years.

The discovery opened a field of interesting speculation. If the sun's heat is to decrease at the rate of 3 or 4 per cent a year, what will be the result in, say, 50 years? We have just passed through an exceptionally cold spring. Was that the first warning given us that the sun, after millions and millions of years, is at last going on strike?

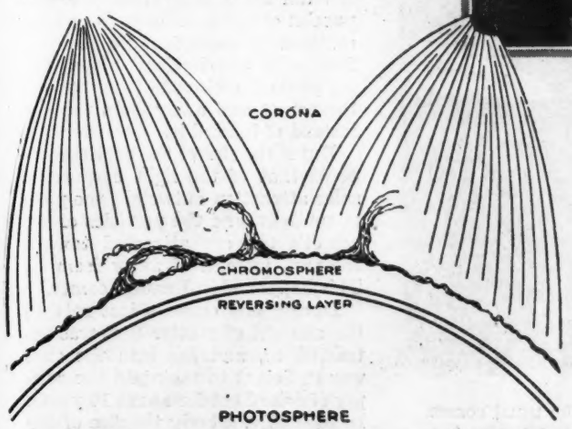
Although we have still much to learn about the sun, we know that without the sun we could not live and our earth could not flourish. Withdrawal of sunlight and heat, even for a limited period, would plunge us into darkness blacker than the blackest night, and into a cold infinitely more bitter than that at the poles. There could be no crops. The water which makes up two-thirds of our globe would be turned to ice. The artificial means of producing light and heat which science has supplied us would be useless. We would be helpless to exist on earth!

Courtesy G. P. Putnam's Sons

Enormous tongues of scarlet, flaming hydrogen shoot outward from the surface of the sun, sometimes rising to a height of 500,000 miles into space



This huge telescope in the new observatory at Potsdam University, Germany, is expected to give astronomers new knowledge of the sun during the eclipse of September 10



This diagram shows the chief layers of the sun—the photosphere, a brilliantly luminous envelope of vaporous matter; a reversing layer of cooler gases; the chromosphere, a sea of fire, and the corona

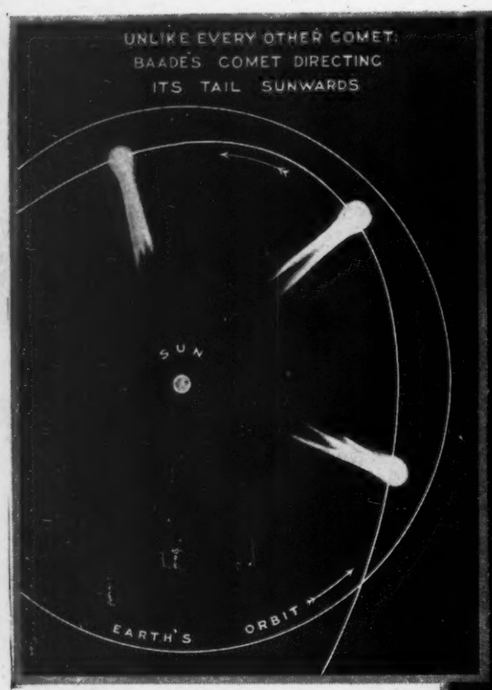
Science tells us that the sun is a huge ball of fire—and yet not fire as we understand it on earth—one hundred times larger than the globe we live on, and 93,000,000 miles away from it. It is a boiling ocean of white hot vapors, the surface temperature of which has been estimated to range from 9,000 to 13,000 degrees F., and from which at times have been flung flaming columns of gases, traveling 60,000 miles an hour and shooting a half-million miles into space.

Astronomy has divided the sun into definite concentric layers, which envelop the nucleus or central body somewhat as the atmosphere envelops the earth. Of the innermost region virtually nothing is known. Of the next exterior region, which the astronomer calls the "photosphere" and which we see as we look at the sun, considerable has been learned. Indeed it is through study of the photosphere that most of our knowledge of the sun has been derived. Upon the photosphere lies a third outer layer—the "chromosphere," a red sea of fire 5,000 to 10,000 miles in thickness; and beyond that, gradually fading away into the sky, is the corona.

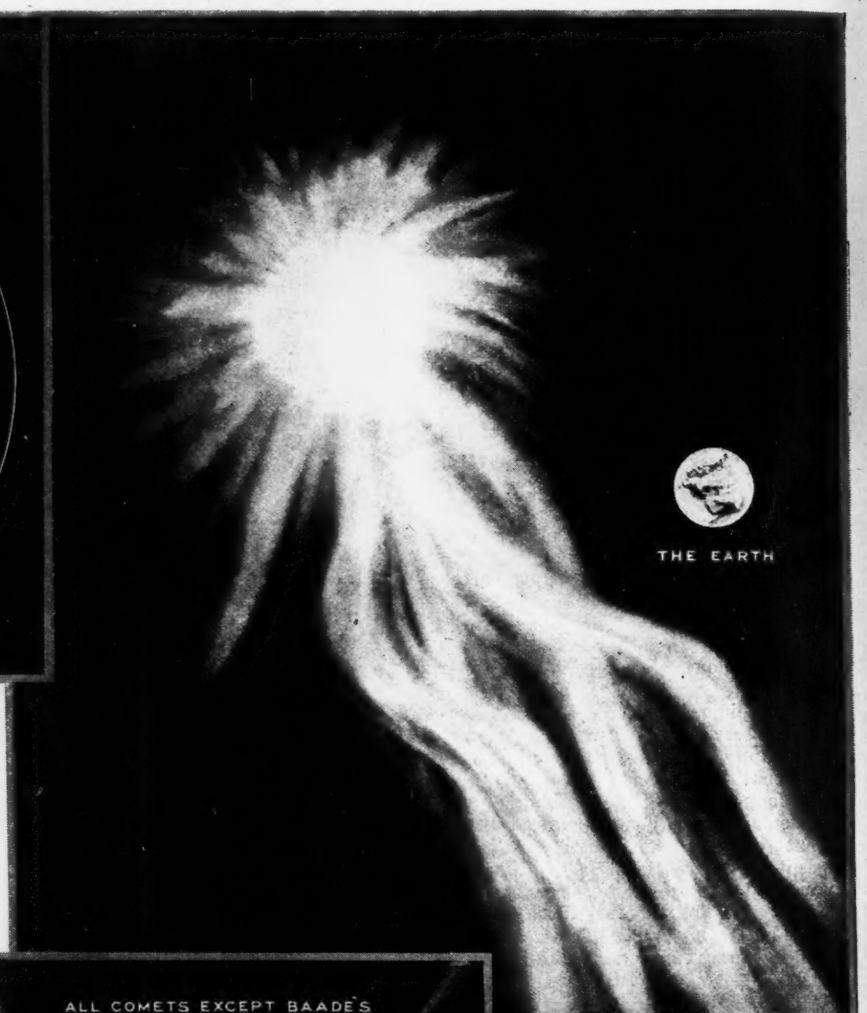
Whether the center of the sun is solid or gaseous is not definitely known, but from study of the photosphere by means of the spectroscope, astronomers have reached the opinion that it is gaseous. This study

(*Turn to page 97*)

Inverted Comet Adds Fuel to Sun



The path of Baade's comet, with its tail toward the sun, is shown above in relation to the earth's orbit. Particles pulled from the comet's head supplied 10 years' fuel for the solar furnace



Here is a close-up view of Baade's comet with its tail blown toward the sun. It was literally turned upside down and photographs showed it disintegrating rapidly

By Scriven Bolton, F. R. A. S.

THE only comet ever known to turn its tail toward the sun—one that supplied 10 years' fuel to the great furnace of the sun—is Baade's comet, recently discovered by Walter Baade at the Bergedorf University Observatory, Germany.

Baade's comet undoubtedly is the heaviest comet in proportion to its size ever discovered. The constituent parts of which it is composed are much heavier than those of other comets. It is because of this fact that it has broken completely the hard and fast rule relating to the behavior of comets' tails.

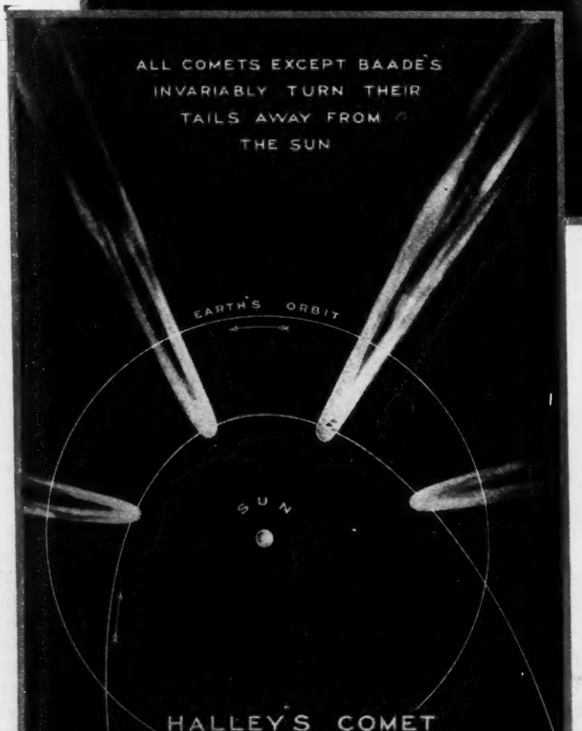
In every other comet that has been observed the tail always has pointed away from the sun. This is because the tail is formed by the pressure of sunlight. Comets are clouds of gas, perhaps with some solid fragments, that come into our solar system from the outer space. Most of them go out and never are seen again, but a few, such as Baade's comet and the famous Halley's comet, have regular orbits around the sun and come back again and again.

Sunlight falling upon a small solid body or sphere, has power to exert a pressure or push upon it, in a direction away from the sun. This is because light itself is believed to be composed of tiny corpuscles of matter, reckoned by billions for every square inch, and traveling out from the sun at the rate of 186,000 miles every second. The smaller the sphere, the more it is influenced by the push of light, and less by solar gravitation.

In the usual comet, the very tiny particles of matter that make up the tail are smaller than the corpuscles of light. The push of light on these particles is more powerful than solar gravitation. Thus they are pushed back out of the head of the comet and away from the sun instead of toward it.

But if the size of the particles exceeds that of the light corpuscles, solar attraction outweighs the push of sunlight, and the particles of the comet's tail are attracted toward the sun, instead of away from it. This happened in Baade's comet.

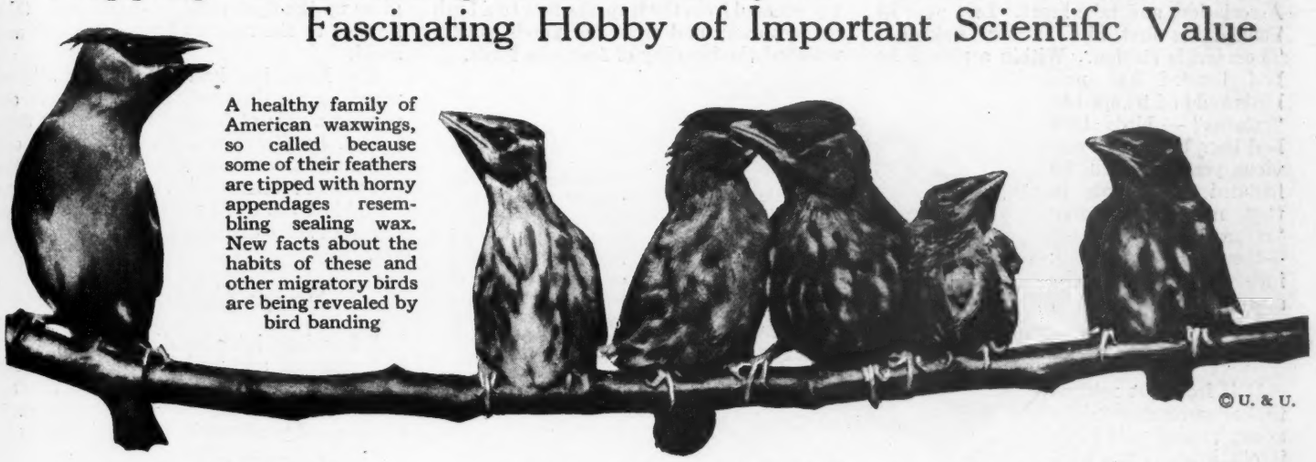
During the comet's last return, the amount of matter that was attracted to, and fell into the sun, was sufficient to maintain the supply of solar heat for about 10 years. Incidentally, a body the size of the earth, if plunged into the sun, would keep the solar furnace going for 95 years.



The famous Halley's comet follows the usual comet behavior—the tail invariably points away from the sun. The record of the appearances of Halley's comet every 76.8 years dates back to 240 B. C. Its visits alarmed Europe during the middle ages

Wild Birds Studied by Tags

Trapping and Banding Annual Backyard Visitors Is New and Fascinating Hobby of Important Scientific Value



A healthy family of American waxwings, so called because some of their feathers are tipped with horny appendages resembling sealing wax. New facts about the habits of these and other migratory birds are being revealed by bird banding

© U. & U.

By Manus McFadden

HOW would you like to contribute something to science and at the same time increase your own joy in life?

Here's your opportunity. Take up bird-banding, the science that is a sport. It is a fascinating science of discovery—the discovery, by means of identification tags, of the travels, habits, and individual characteristics of migrating birds that you see every day about your home.

You don't have to be an ornithologist to pursue this hobby, but you soon will be, if you keep it up. The birds will see to that.

And the government will see that you get started right; will give you a permit to trap birds in or out of season, and will supply you with officially numbered aluminum bands for marking your birds, provided you agree to band at least one bird a year and send the record to Washington.

It is easy to become a bird bander. All that is needed is the government permit and a trap that can be made at home. The U. S. Biological Survey, realizing the scientific value of banding, now is experimenting with various types of traps at Washington, D. C., and will supply full directions for making them.

The ease with which fascinating knowledge of bird life may be gained by any one is illustrated by the experiences of S. Prentiss Baldwin, of Cleveland, O., president of the Inland Bird-Banding Association, which covers the middle western states. Mr. Baldwin maintains two big stations, one on a farm near Cleveland and one on a plantation at Thomasville, Ga. He started banding birds a few years ago as a sport; today he is a recognized authority in ornithology.

You can do the same. By setting up an inexpensive trap in your back yard to catch birds for banding, you can make friends with the robins that return to your yard every spring. You can know them *personally*. You can learn to distinguish your robin from the robin that calls at the house next door. You can win personal friends among all the other wild birds that roost in your trees or hop about your grass. Finally, you may be surprised to learn that some of your new friends may return to you year after year.

You may be surprised, too, when you discover that birds and human beings have much in common. You will find that each of your bird friends has a distinct personality; that some are affectionate while others of the same species are aloof and suspicious of you; that while most of them follow well defined habits of the species, some, like people, have amusing idiosyncrasies; that mother love is so strong in them they will adopt fledglings, and that the mother birds, like human mothers, have their worries in proper care and feeding of their babies.

You will even find if you want to delve into their family life, that your beloved Jenny Wren and her mate are frequently divorced. This failing of wrens was never discovered until the birds were banded, until their legs were tagged with numbers by which ornithologists were able to check them when they changed mates.

The method of catching and banding the birds without injury is a simple one. Two types of traps are shown on these pages. When the trap is baited with fine grain or bread, the bird will enter of its own will. Then it can be driven into the gathering chamber. In removing a bird from the chamber grasp its head between your first two fingers. It will use your little finger for a perch and will remain quietly. Using both hands, turn the bird over, securing its head with the little finger and grasp the left leg with the first two fingers. Then adjust the aluminum band about the leg, pressing its split edges together with a pair of pinchers. To release the bird simply open your hand, leaving the bird lying on its back. When it finds it is free it will fly away.

Interesting new facts are being revealed every day by American bird banders. It may be that the age-old mystery of what becomes of the chimney swift in winter will soon be solved. In fact, the very band you place on a bird with your own hand may bring the solution.

Every fall, flocks of swifts drift southward until they gather in innumerable hosts on the northern coast of the Gulf of Mexico. Then they disappear. If they dropped into the water or hibernated in the mud, as was believed of old, their obliteration could not be more complete. Along about the last of March each spring they suddenly reappear on the Gulf Coast. But just where they spend the winter is still their secret.

Scientists believe our swifts winter in South America, where many of the migrating birds from North America go. But the fact never has been proved. The finding of a swift in the winter

How the bird is held for banding, without injury, in the left hand while the small band is fastened about its leg with the right hand. Note band on left leg of this brown thrasher

This flat net type of trap can be made easily by tacking wire netting over a shallow frame. After the trap is dropped, the birds are driven through a passage into the small gathering box shown at the left

time will solve the mystery, provided the finding is reported. If the bird is banded with the mark of the U. S. Biological Survey it is more than likely to be reported.

If you doubt your ability to band birds successfully consider the experience of L. B. Talbot, of the New England Bird-Banding Association, and take heart. Last year he banded his first bird at Mr. Baldwin's Thomasville station. Within a month he had banded 313 new birds and had trapped 43 "returns" — birds that had been banded in previous years. In all, he handled 1804 birds in that month, including "returns" and "repeats" —those that went back into the traps on the same or succeeding days.

Keeping Records

It is from the returns that all government data about banded wild birds is obtained. Each bird banded is numbered and a record is kept of its movements. The age of blue jays, for instance, was learned in this way. No. 1916, a blue jay, was first banded in March, 1916, by Mr. Baldwin at his Thomasville place. The bird was trapped again in February, 1920, and a third time in March, 1922. Since the jay originally was caught in its first year, the records proved that the bird had attained an age of at least six years. This fixing of the age is an important item in bird study. It shows how long the year's hatch of any species may be expected to live. In conjunction with local bird censuses now being taken it will help give an approximate total of the birds in the United States.

Birds Return

Another interesting return record, one of several which have proved conclusively that birds return to the same place year after year, was made on the farm near Cleveland. In June, 1916, No. 38461, a chimney swift, was caught in the north chimney of the farmhouse. In June, 1917, and June, 1919, the same swift was recaptured in the same chimney. And this bird had spent five months out of each year in its secret hiding place below the equator!

The returns to the traps also have served to reveal the personalities of individual birds. In this connection William I. Lyon, of Waukegan, Ill., has had some interesting experiences. No. 17042, a white throated female sparrow which has returned to his traps on numerous occasions, always has shown an unusual disposition for tameness. Like most chipping sparrows caught in the traps, she likes to be cuddled. Recently, when being released from the trap, she flew to a bush six feet away and from her perch quietly watched the banding of four new birds.

To release a bird simply open the hand, allowing the bird to lie on its back. When it discovers it is free it will fly away of its own accord. The brown thrasher shown here evidently is taking its own time to get away

How to hold the bird for examination. With its neck held firmly but gently between the first and second fingers, the bird will use the other fingers for a perch. This mourning dove is not at all frightened in captivity

To change the position of a bird while handling it, pick it up by the head. In this position, strange to say, the bird remains quiet and unhurt. Notice how calmly this chimney swift is taking the operation

In contrast to her behavior, No. 17070, a male of the same species, is a fighter of unusual ability and proclaims it in a very loud voice. He starts his challenging as soon as a hand reaches into the trap. When the hand approaches him he attacks, picking the fingers with all his might. He never gives up the fight until he is released; then he flies to the nearest branch to sulk and scold.

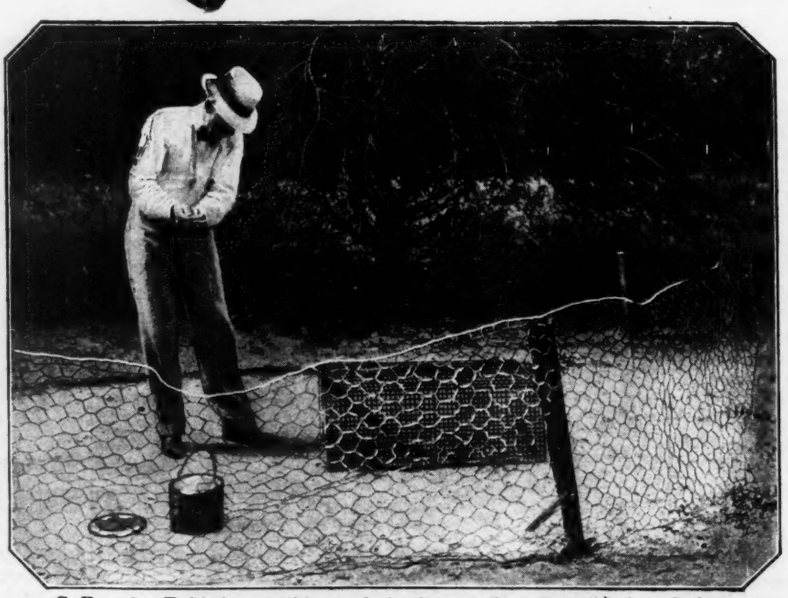
Mr. Lyon has had the opportunity of watching a real tragedy in bird life. In observing a pair of banded flickers and their young, he discovered that a screech owl had made a nest near by. Fearing that the owl would interfere with the young flickers he robbed the owl's nest and removed her to a spot some distance away after banding her.

Strange Habits Learned

A few days later he discovered the owl had returned and had invaded the flicker nest. He promptly threw her out. This performance was repeated for several days but the owl persisted in staying in the nest. She did not attack the young flickers; on the contrary she brought the birds she had killed for food. Although her foster fledglings would not eat the food, the owl kept it up until they were old enough to fly away and desert her. This is believed to be the first official record of bird kidnapping.

One bird bander had a robin that became a pet from frequent trappings. This bird developed a taste for ice cream and would wake up as late as 9 o'clock in the evening to eat it if it were offered to him.

Another enthusiast, Dr. R. D. Book, of Corning, Ohio, has taught wild birds to eat various foods they were not used to. He has derived considerable amusement from watching them eat macaroni, shaking it as they would shake a worm to "kill" it. Dr. Book also had an interesting experience with a female titmouse that was hatching a brood. He had banded this bird and her mate, and they had become so well acquainted with him that the male would alight on his hand to eat pie crust. The female craved the crust and would leave her nest and cry for it until her mate carried it to her. This he always did before eating any himself. But after the eggs were hatched the mother bird, though coaxed by the male, never would touch the pie crust again.



S. Prentiss Baldwin, president of the Inland Bird Banding Association, scattering bait for a double funnel trap of wire netting. The birds follow a trail of crumbs into a chamber in the rear, where they are captured

Saving the Birds

And so it is that bird banding every day is revealing new facts about the life and habits of individual birds. What is the purpose of it all?

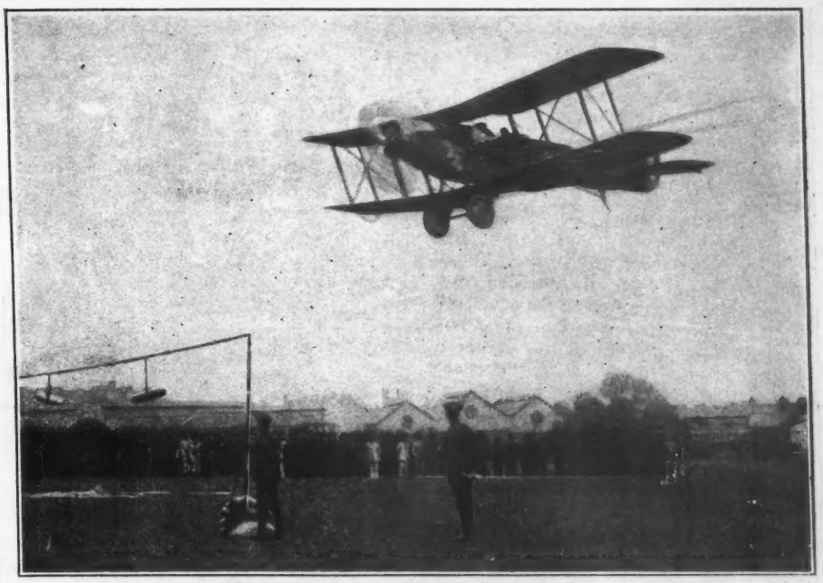
Aside from the fascination of nature study, the chief purpose is bird conservation. Ornithologists hope soon to complete an approximate census of the birds in the country. With this information they will be able to guide intelligent legislation for the protection of birds and avert another tragedy like the extinction of the American wild pigeon. They hope to preserve the birds who are aids to mankind, including the insect destroyers that rid our farms and forests of destructive pests.

Revolving Lamp Shade Is Novel Advertisement

PARCHMENT lamp shades, which lately have achieved wide popularity in the home, are employed by an Indianapolis company as an advertising novelty. The illustration shown here indicates how a parchment shade may be used in advertising a brand of cigars.

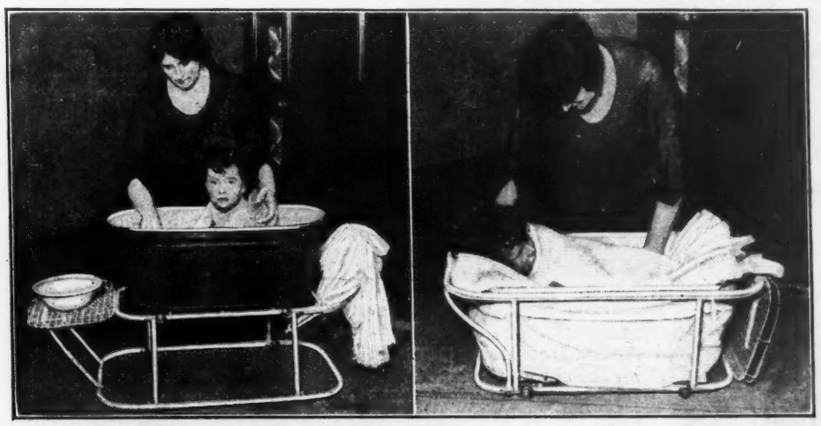
Parchment lamp used as cigar advertisement

On the opposite side of the shade appears the name of the cigar, which is made to revolve into view by the heat of the incandescent lamp. The advertising lamp is intended for use in store windows and in soda fountains, on cashiers' desks, restaurant tables and other places where the attention of the passing public will be attracted.



Army Airplane Picks up Messages from Ground

A SPECTACULAR demonstration of the employment of airplanes to cooperate with the infantry by picking up messages from the ground and delivering them, was witnessed recently at Brickfields, Plymouth, England. The photograph shows a plane about to pick up a message attached to a line.



Bathtub for Baby Folds into Snug Cradle

MOTHERS everywhere will be interested in a new combination baby's bathtub and cradle invented by Mrs. Charles Dancy, of Chiswick, England. At the left the device is shown in use as a tub. When folded, it forms the cradle at right.

Illuminated Bonnet Shaped Like Capitol Dome

AN ILLUMINATED bonnet in the shape of the dome of the state capitol at Sacramento, Calif., was an advertising oddity seen by tourists in California recently. The hat was worn by Miss Eleanor Posey, a native daughter of Sacramento, to advertise the beauty of her city and of the Sacramento Valley.

The lights are operated by a small dry battery, with push button

The hat is surmounted by an orange colored electric bulb, while inside are a series of lamps that give the entire crown a soft, blue glow. The lights are operated by a small dry battery and a push button hidden in the loose sleeves of the wearer's dress. The wires also are cleverly concealed in the garments.

Philadelphia Building Wrecked by Rainfall

THE wrecking of the building shown at the right is almost directly traceable to a gentle rainfall in Philadelphia recently.

This lumber storehouse had a flat tar and gravel roof and a drain pipe that was stopped up. Tons of water from heavy rains had accumulated on the watertight roof, having been impounded within walls of masonry that rose about three feet above the roof surface.

A slight storm added enough water to that already there to cause the beams and joists to give way.

Building demolished by the weight of water on its roof

THE editor will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in Popular Science Monthly.

Above, horses lined up at the starting platform. At left, propelling a horse along the rail by pushing hand levers

Hand-Driven Race Horses Run on Monorails

A NOVEL horse racing amusement device recently introduced at Ocean Beach, Calif., consists of a series of wooden steeds running abreast on tracks and propelled by the riders. The thrills and excitement of real horse racing are duplicated as the amateur jockeys travel the 500-foot course on steel rails.

The horses running on four parallel monorails are propelled by moving back and forth two levers that operate the driving mechanism.

Old-Fashioned Bell Pull for Electric Switch

THE old-time bell pull has been revived recently as a home decoration to take the place of the somewhat unsightly buttons on the ordinary switch plate for turning electric lights on and off. The switch is turned by pulling a tasseled cord.

A pull on the decorative cord switches the electric lights on or off

Centrifugal Honing Tool Grinds Auto Cylinders

A HONING tool for grinding motor cylinders, which requires no abrasive materials, liquids or lapping compounds, which automatically fits itself without adjustment to any cylinder from 2 13/16 to 5 inches in diameter and which is self-centering and self-aligning, has been developed by a Chicago manufacturer.

The stones used remove metal from the cylinders without loading, and polish the surface in one operation. Centrifugal force developed in rotation causes the parts to adjust themselves to the size of the cylinder.

The tool is driven at a speed of from 800 to 1100 revolutions a minute and can be operated by a portable electric drill, standard drill press or honing machine.

Ancient Indian Workshop Found at Dam Site

CONSTRUCTION of a dam across the Susquehanna River near Conowingo, Maryland, is speeding up an archaeological investigation of a prehistoric Indian workshop on an island eight miles above that place. For years John L. Baer, of the U. S. National Museum, has been seeking the solution to the mystery of curiously wrought stones found in abundance there.

"Banner stones," as the specimens are called, are believed to have been ceremonial objects carried by the Indians. They are unknown west of the Mississippi, but in New Jersey they have been found under other Indian material which indicates that they are very old. They probably were intended to represent birds and butterflies.

Metal Shield Aids Typist in Making Erasures

TO AID the typist in making erasures when a carbon sheet is used in the typewriter, a newly invented metal shield is inserted between the first sheet of paper and the carbon.

How the metal shield is inserted

Often, when carbon sheets are used, the type makes impressions in the white paper that are difficult to erase. The hard metal surface of the new erasing shield tends to iron out these indentations during the process of erasure, forcing the ink back to the surface where it can be removed easily.

The back of the shield is covered with a felt pad that rests against the carbon sheet, distributing the pressure evenly so that the carbon will not blur the duplicate paper.

Radio Set and Phonograph Combined in Lamp

AN INGENIOUS combination table lamp, phonograph and radio outfit has been perfected by F. W. Hochstetter, of Dayton, Ohio.

The same magnetized diaphragm that is used in the loud speaker when the lamp is employed as a radio receiver, will play phonograph records when a needle is inserted. This diaphragm resembles a camera shutter in form and may be opened and closed to regulate the volume of sound.

This diaphragm regulates volume of sound

The lamp is of copper and with the electric wires serves as an aerial when the outfit is used for radio reception. The crystal detector receiving set, for which no batteries are required, is contained in the spacious pedestal of the lamp, as is also the phonograph mechanism. The base of the lamp is designed to serve as a sound box.

The inventor, F. W. Hochstetter, operating his combination lamp, phonograph and radio receiving outfit

Compact Auto Kitchenette Convenient for Tourists

FOR the automobile tourist, one of the new conveniences is an ingenious auto kitchenette invented by Miss Lou Shields Gilmore, of Los Angeles. It consists of a cabinet attached to the running board, containing a refrigerator, compartments for food and dishes and a water tank.

The entire outfit weighs only 55 pounds and can carry ice enough for two days and sufficient food to supply a party of five or so for a longer period. With the addition of a small oil stove, the camping or touring party's equipment is complete.

"Machine Gun" Duplicator Saves Typist's Time

TO PREVENT waste effort and duplication of work in the writing of business forms—invoices, orders, requisitions, bills of lading and similar records ordinarily requiring many carbon copies—a rapid fire duplicating machine has been perfected by a nationally known manufacturer.

Instead of making many changes of carbon sheets and cut forms, with this machine the operator may load up once and continue uninterrupted until the work is completed.

The manufacturer compares the operation of this device with that of a machine gun. The machine has a "magazine" of 1000 sets of form and 750 feet of carbon paper. It permits the typist to use in actual writing the time ordinarily lost in preparing to write.

THE EIFFEL Tower will last for 23 years more, according to engineers who recently examined its stability as the result of a report that it was falling down.

Portable Factory Elevator Lifts Loaded Skids

A NEW time and labor saver for factories where heavy material is carried from place to place is an elevating truck that can lift entire rolling platforms and their loads to a height of five feet. The platforms are lifted by an elevating shelf running on a truck framework and driven by an electric motor.

The upper photograph shows a skid, fully loaded, picked up by the elevator truck. Below, the skid and its load elevated for discharging

Speedy Fighting Plane Has Novel Wing Design

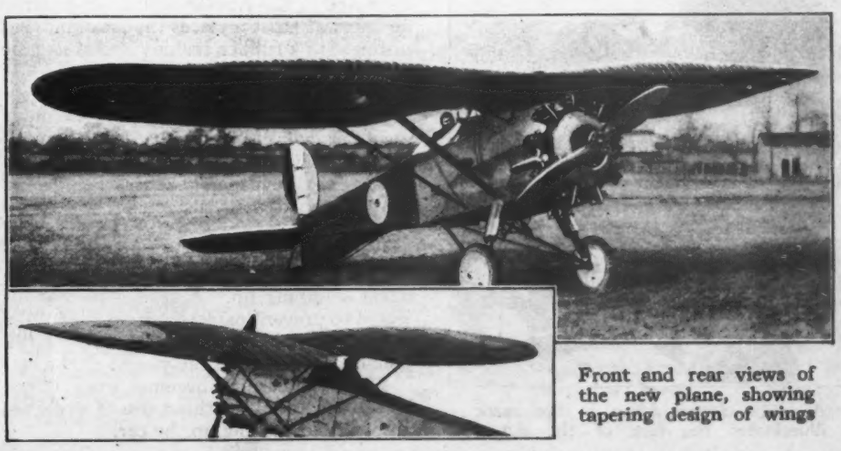
A NEW high-speed airplane of the fighting type, which is expected to beat all records in aeroplane performance, has been completed for the British Air Ministry. Its outstanding feature is the unusual wing shape, thin at the center, thickening towards the inner third of the span, and tapering finally off to a fine line at the outside. It is operated by an air-cooled motor.

The new machine embodies the advantages of the cantilever and braced types of wings without their disadvantages. The bracing has been reduced to a minimum, for only two small steel struts are fitted at each side. Where the struts are joined to the wing, the section of the wing is thickest, since the greatest stresses occur here. Where the stress is less, the thickness of the wing has been reduced; for the thinner the wing, the greater its efficiency. Both fins and rudders are cantilever surfaces.

An air-cooled engine developing 400 horsepower is used in the new machine. In recent official tests, the engine broke all endurance records for air-cooled engines, running for 150 hours, including a non-stop run of 50 hours. Fitted to a modern fast scout, this is equivalent to three trips across the Atlantic.

After the test, the engine was dismantled, and the maximum wear on any part was found to be less than one-two thousandth of an inch, proving that aircooled engines, even of very great power, can safely be fitted to airplanes serving long distance routes.

As an aircooled engine is much lighter than a water-cooled one, and does away with radiators, water piping and tanks, a great saving in weight can be effected, it is claimed. Doubtlessly airplanes of the future will be propelled by aircooled engines.



Front and rear views of the new plane, showing tapering design of wings

One-Man Bus Has Periscope Sight

At the left, the one-man double deck bus, showing automatic safety doors and the periscope, through which the driver sees passengers on the upper deck of the car

Below, the driver's seat, with door control, coin box and periscope sight

EQUIPPED with a periscope, a double-deck omnibus that may be operated by one man successfully has been designed and built by a New York inventor and has been placed in regular service.

The vehicle is of the pay-as-you-enter type, a coin box permitting the driver to collect fares. A periscope directly in front of the driver's seat enables him to view all parts of the upper and lower decks of the car, and to see signals waved to him by the passenger. There also is a telephone beside him through which he can make announcements to the passengers.

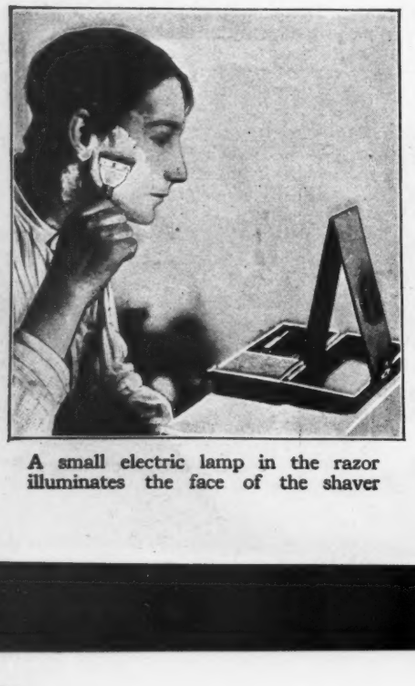
A safety automatic door by which passengers may leave the car from the rear is controlled by a lever at the driver's right hand.

John Catoff, who was associated with the designer, Emil Leindorf, in making alterations to the original model, is shown here in the driver's seat.

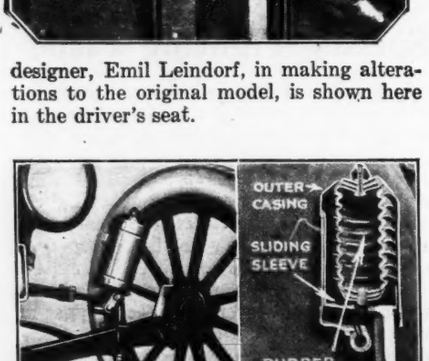
Clean Shave in the Dark with This Safety Razor

DESIGNED especially for use by traveling men, a self-illuminating safety razor makes it possible to shave in the dark.

In the handle of the razor is a tiny electric bulb, encased in a rubber holder which prevents dampness from rusting it. The lamp is adjusted so that it always throws its light on the spot where the razor is cutting. A clean shave in pitch darkness is said to be possible with this device.



A small electric lamp in the razor illuminates the face of the shaver



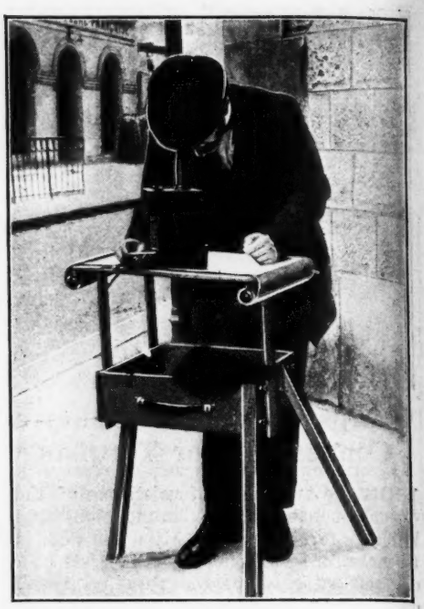
New Shock Absorber Has Rubber Air Cushion

AN EFFICIENT and inexpensive pneumatic shock absorber for light cars, perfected in Los Angeles, differs from other designs in that it replaces the usual moving piston with a rubber cushion containing air under pressure.

The sectional view of the shock absorber above shows the construction. An outer casing or cylinder is attached to the spring shackle, while a sliding sleeve is bolted to the axle. This sleeve merely acts as a guide and container for the air cushion. The cushion bag is built up of gum stock and cord fabric.

An ordinary tire valve at the upper end of the shock absorber makes easy the infrequent pumping up. A special fluid is injected to prevent oxidation from the inside. Pressure is maintained at from 80 to 100 pounds, according to the weight of the car.

When the cushion becomes worn, it can be replaced easily without use of wrenches and without jacking up the car.



Surveyor Maps as He Goes With New Instrument

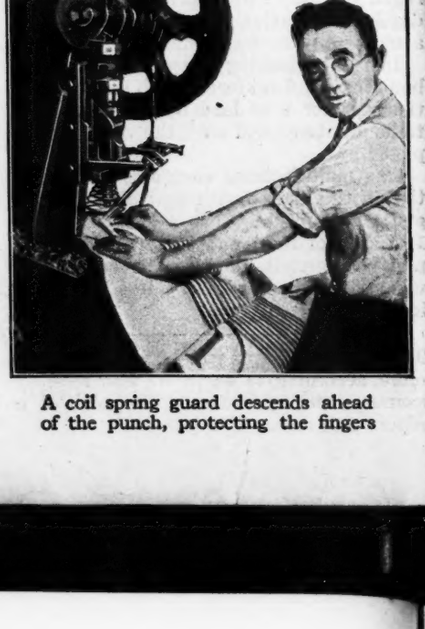
A FRENCH inventor is responsible for this ingenious surveying instrument, which establishes lines and slopes, measures distances without use of a tape and permits the surveyor to draw map as he proceeds.

The surveyor may take his sights through the vertical tube in any direction without moving around the table. This is made possible by a complicated arrangement of prisms and lenses within the instrument. The instrument is moved into line by a finely-adjusted milled head. When a line is established on a rod, a ruler at the side of the box guides the surveyor in laying it out on his board. Since the lines are drawn on paper which is ruled to scale, they show distances with sufficient accuracy.

Spring Guard for Punch Press Saves Fingers

FINGERS of Post Office Department workers employed in the manufacture of mail bags are protected by a spiral spring guard from injury in punch presses used in inserting eyelets in the heavy canvas.

The guard surrounds the punch and moves in advance of it, giving warning of the descending stroke.



A coil spring guard descends ahead of the punch, protecting the fingers

Blindness Lurks in the Teeth

How Science Has Restored Vision by Uprooting Hidden Poison Factories

PHYSICIANS to-day agree that decayed teeth and infected gums may cause serious diseases, even blindness and death.

In the following article a national authority on the relation of teeth to health tells what science, with the aid of the X-Ray machine, has learned about the poison factories hidden in the roots of our teeth or around the margins of our gums.

He tells why scrupulous care and repair of teeth is one of the most valuable forms of life insurance.

By Edwin F. Bowers, M.D.
Noted American Authority on Teeth and Health

Katherine Bryden, of Grantwood, N. J., whose abscessed teeth caused total blindness and finally nervous prostration. Extraction of teeth restored sight and health

FOUR hundred million defective teeth exist in the United States—about four defective teeth to each person. If all these teeth were cared for properly, an average of 10 years would be added to the life of every normal man, woman and child in the land.

Among school children dental disease is so common that only about three children in a thousand have perfect teeth.

These recent estimates by the Columbia University School of Dentistry reveal a source of untold disease, misery and even death that might be prevented absolutely if we as a nation would learn how to take care of our teeth. Their importance can hardly be over-estimated. For scientists have proved positively that the health of our bodies depends largely upon the health of our teeth. In fact, so closely interrelated are teeth and health that not even the greatest expert can tell where one leaves off and the other begins.

We recognize, of course, the importance of teeth in preparing food for digestion. Without proper breaking up of the food, the digestive juices cannot attack it and complete stomach digestion.

Poor Teeth—Bad Nutrition

Poorly prepared food—poorly prepared because of bad teeth or lack of teeth—thus may be considered as a primary cause of faulty nutrition, resulting in anemia, neurasthenia, and the host of symptoms that follow chronic indigestion and auto-intoxication from intestinal absorption.

There is a very close relation, too, between decayed teeth and a large number of diseases that apparently have nothing to do with the teeth, such as ulcers and cancers of the stomach, rheumatism and diseases of the kidneys.

Pathologists tell us that, in many instances, the germ or strain of bacteria found in a diseased appendix was first developed in an infected tooth or an abscessed gum. The infected germ is carried in the blood stream, until it finally lodges in the vulnerable appendix.

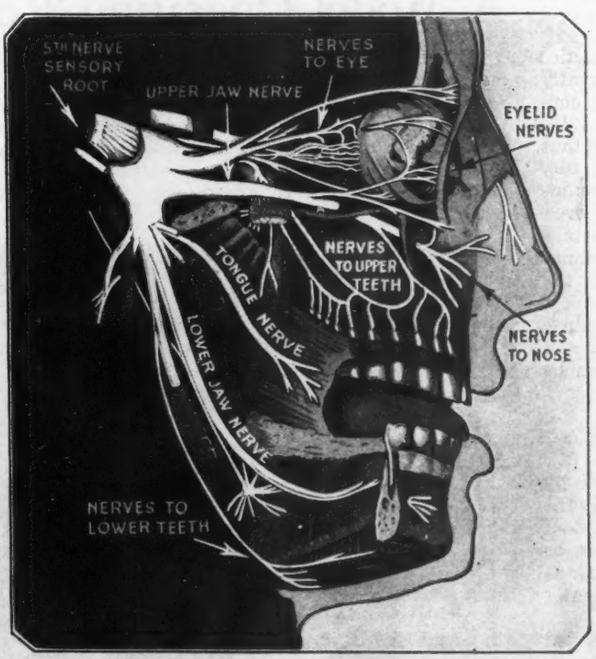
The relation of decayed teeth to decayed lungs also is a most intimate one. We are spending much time, money and thought upon tuberculosis and its prevention; yet how many of us realize that many cases of tuberculosis can be traced directly to malnutrition caused by improper chewing of the food, or from the direct infection of diseased mouths. The germs of tuberculosis almost always enter the system through the mouth and the breathing passages. Therefore, bad mouth conditions are a fertile source of aid to the ravaging germs of tuberculosis.

Many cases of mouth-breathing and adenoids arise because of neglect of brush, tooth paste and elbow grease, persistently applied. Ulcerated tonsils and swelling of the glands of the neck, and those very serious diseases of the cavities of the facial bones (sinus abscesses) develop quite frequently from an infection of the teeth.

In fact, the malignant germs, breeding in infected teeth and gums, together with the poisonous products they engender, may be absorbed into the blood, or the lymph stream, and thus be carried to every cell in the body. The damage they may do can be measured only in terms of their own harmful activity, plus the lowered resistance of the tissues in which they finally lodge.

Even total blindness has been traced to poisonous conditions of the teeth and gums. In many instances, perfect vision has been restored by the correction of abnormal oral states. Among a number of such cases brought to my attention is that of Miss Katherine Bryden, of Grantwood, N. J. Miss Bryden was 23 years old last May. Until 12 years ago, she enjoyed perfect sight in both eyes. But in November, 1911, her vision gradually faded, until finally, she became totally blind in the right eye, and retained hardly more than perception of light in the left.

Three years ago, Miss Bryden's health failed utterly. She suffered from nervous prostration and was rarely free from "colds" and throat trouble. Appetite and nutrition were affected to such an extent that she lost more than 30 pounds in weight.



How the nerves of the teeth, eyes, eyelids, nose, jaws, lips and tongue are interrelated through the trigeminal, or fifth nerve, is shown in this diagram

Sight Is Restored

Finally, Miss Bryden was examined by a New York specialist in oral surgery and an authority on X-ray diagnosis. He made a series of X-ray photographs of this patient's mouth. Numerous abscesses, as shown on page 50, were revealed. Extraction of all the upper teeth was advised.

The results of this extraction were almost miraculous. The patient's vision improved immediately. Her throat trouble vanished and she gained steadily in weight, in appetite, and in her ability to digest and assimilate food. Her bodily resistance has

been so enhanced that she hasn't had a "cold" for upwards of two years.

The explanation for this miracle of healing is simple enough. The germs and poisonous products that had exerted their disturbing effect on the functioning capacity of the optic nerve were removed—therefore sight came back. At the same time, every cell and tissue in the body was relieved of an overdose of poison, and began to function normally.

There is hardly an oral surgeon in active practice who cannot detail cases that seemingly have not the slightest connection with the teeth, yet which have made complete recovery, following the extraction of abscessed teeth, the clearing up and proper filling of infected root canals, the aseptic treatment of pus-laden pyorrhoea packets, or the removal of a molar tooth—buried crosswise in the jaw.

Neuritis of years' standing, sciatica, rheumatism, neuralgia, headaches, and many other painful conditions have been overcome almost as though by magic, when septic mouth conditions disclosed by the searching eye of the X-ray were cleared up.

I recall another case—that of a healthy, robust looking man, who suddenly began to suffer from neuritis in the shoulder. He had tried all sorts of treatment, diet, mineral water, asperin, and rheumatism medicine, without relief.

How X-ray Aids Dentistry

Finally, an X-ray of his teeth revealed a huge abscess at the apex of a molar tooth that had caused "gum boils." The tooth was removed, with the result that the very next morning this patient was relieved completely. The neuritis never has returned.

The X-ray, without doubt, is the greatest scientific informer of modern times. It most nearly insures the certainty of determining whether or not a focal abscess exists at the root of a tooth, or whether a root canal is, or is not, properly filled.

Nearly every dentist in active practice has seen openings at the roots of apparently sound teeth, through which there is constantly draining poisonous material. Indeed, careful investigators now contend that before the X-ray came into general use, fully 79 per cent of all root canals were imperfectly filled. Faulty dental work—even work done conscientiously and painstakingly by able men—may prove a definite source of danger. Crowns that fail to fit the necks of teeth, badly adjusted bridge work, faulty abutments, overhanging fillings that constantly collect food particles and facilitate decay, almost invariably can be checked up by the X-ray.

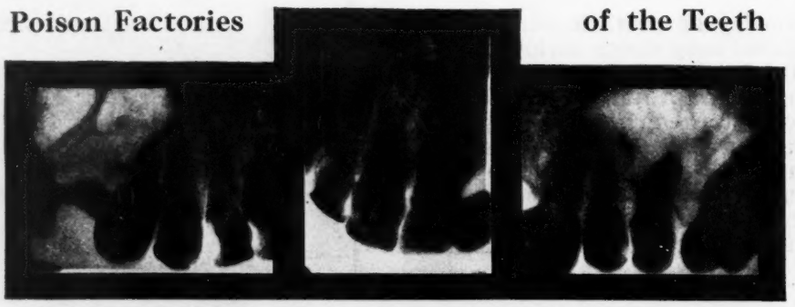
Care of the Dead Tooth

In fact, there is no other method by which a dentist can determine definitely the presence of an impacted molar or wisdom tooth, whether a root filling is perfect, or whether a tooth which he proposes to use as an abutment for a bridge is sufficiently sound for the purpose.

Dr. Thaddeus B. Hyatt, of the Dental Section of the Metropolitan Life Insurance Company, has compiled convincing evidence of the value of the X-ray in determining dangerous infection. In an examination of 2537 teeth with non-vital pulps, 1404 showed pussy conditions in the tissues surrounding their roots.

Strange as it may seem, it is now conceded that a dead tooth requires watching more than does a living, functioning tooth. With its source of nutrition cut off by local tissue degeneration, the dead tooth is much more likely to start putrefactive changes in its surrounding tissue. Abscesses therefore are quite common in these teeth.

Poison Factories of the Teeth



In this typical X-ray photograph of the teeth, the white portions indicate decay, sources of infection. They are poison factories that undermine health

Of 200 cases of dead teeth, examined by the experts of the Life Insurance Institute, 135, or 67 and one-half per cent showed evidence of infection. The total number of abscessed and infected teeth found among these 135 people was 205; while the total number of teeth improperly filled, and requiring immediate dental care, was 193.

In an early issue, an authority on the care and treatment of the eyes will tell how to safeguard the extremely sensitive machinery of vision in the wear and tear of modern life.

The bacteria that actually cause tooth decay finally have been discovered and isolated by Dr. F. E. Rodriguez, Captain in the Dental Corps, U. S. A.

Dr. Rodriguez has isolated three types of bacteria with an exceedingly high acid-producing power. They produce acid fast enough and strong enough to dissolve the hard, limey structure of the teeth, and penetrate right through the enamel into the deep tissue.

There is one phase of the subject of dental care which only within the last ten years has begun to be understood. This has to do with the relation of tooth nutrition to food intake.

Primitive man kept his teeth in very fair condition. This is proved by the condition of the teeth in the skulls in the British Museum and the Smithsonian Institute. They are wonderfully sound and free from evidence of dental decay.

In a large measure, this was due to the fact that primitive man ate his food without cooking it. He tore the flesh from the bones and gnawed these bones in quite as workmanlike a manner as any dog would. Later on—a hundred centuries later, perhaps, he became a grain eater. And on the coarsely cracked grain, baked as hard as a rock in its red bed of embers, he gave his teeth still more exercise. At the same time, he supplied his body with the tooth and bone-making mineral salts which to-day are sifted out from our ground grain, and fed to cattle.

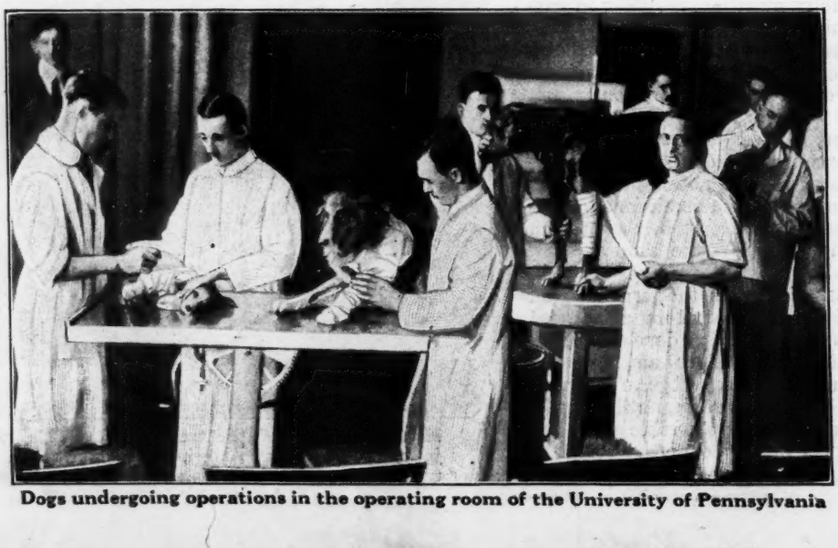
Proper diet, with consistent dental care—which include a semi-annual cleaning of the teeth and gums—is a necessity. In addition, the secretions of the mouth should be rendered neutral or alkaline by the use of milk of magnesia, or milk of lime.

A good dentifrice should be selected, and scrupulous attention should be paid to maitaining a clean condition of the teeth.

A Model Operating Room for Animals

IN THE Veterinary School of the University of Pennsylvania is an operating room for animals which is said to be one of the largest and finest in the United States. Here animals ranging in size from dogs and cats to horses and cattle undergo operations of all kinds performed by experts.

The photograph below shows the department of the operating room devoted to operations on small animals. The surgical methods employed by present day veterinarians are said to equal those used for operations on human beings. The chief surgeon is Dr. John M. Adams.



Dogs undergoing operations in the operating room of the University of Pennsylvania

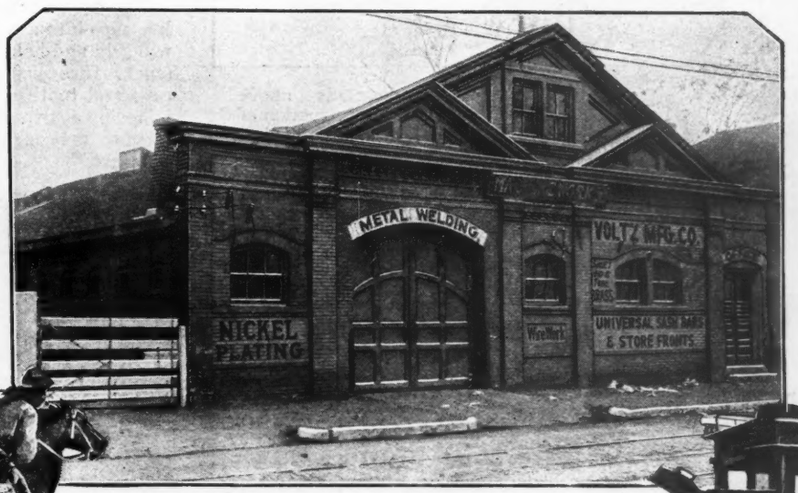
Pony Express Riders to Race Over Plains, Reviving Frontier Days

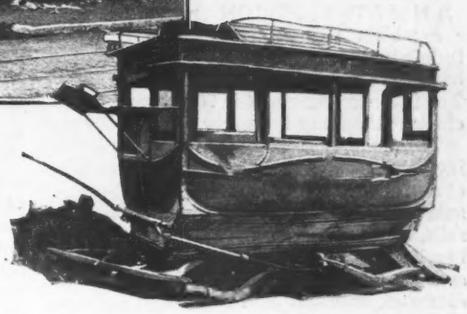
Landmarks of Overland Trail Tell of Scientific Progress

By Al. H. Martin

FOR one thrilling moment this month six states of the Far West — Missouri, Kansas, Colorado, Utah, Nevada and California — will push back the hands of time and live again in the days when sturdy pioneers clashed with the Indians in the struggle for the empire beyond the Rockies.

The occasion is the celebration of the 88th anniversary of the birth of Mark Twain. To represent most fittingly the romance of bygone days a Pony Express race will be held from St. Joseph, Missouri, to San Francisco over the old Overland Trail, traversed by "Buffalo Bill" Cody and the other famed mail riders of the plains.





A landmark of Western progress. From this very building—the "Pikes Peak Livery Stable" in St. Joseph, Mo.—Pony Express riders started their swift journeys westward half a century ago. The building now houses a machine shop. At the right is the old stage coach in which Mark Twain, Horace Greeley and other celebrities rode.

Hundreds of horses and scores of riders will be used in the 2000-mile jump, over which a mail service by relays of swift mustangs was begun 63 years ago, before railroads and fast mail trains conquered the magnificent distances of the western plains. Wherever possible, conditions of the past will be duplicated. The riders of to-day, of course, will not meet the perils of attack by Indians and robbers and the going will be better from start to finish.

Old Landmarks Still Remain

Modern progress has supplied good roads dotted with guiding signs for motorists, bridges over streams which the riders of old had to ford, and well marked, protected passes over ranges of the Sierra Nevadas. But the path traversed will be the same old Overland Trail which riders of the sixties used to negotiate in eight days.

Many of the old landmarks still remain along the route, although their appearance has been changed interestingly by the march of modern science. Such a reminder of the romantic days of the past is the "Pike's Peak Livery Stable" in St. Joseph, Missouri, from which the riders started on their journeys westward. The building now is a machine shop!

From eight to 10 days will be allowed for this month's race, but the riders, aided by modern conditions, are expected to shatter the best records of those they will emulate.

First announcement of the formation of the Pony Express was made in March, 1860. The whole country was startled by the promise that the new service would carry mail from Missouri to the Pacific coast in eight days, instead of the three weeks required by the Overland Stage, inaugurated shortly after the California gold rush of 1849.* To the public 63 years ago this event seemed even more momentous than the government's announcement, this summer, of a 28-hour coast to coast airplane mail service.

A typical view along the historic Overland Trail. At the left is a rider of the plains with his swift footed mustang

©Paramount Pictures

In the early days of the Pony Express, tremendous feats of courage and endurance were required of the riders. The first riders of the service had to make a run of 55 miles before being relieved. Later the length of the successive relays was shortened to 33 miles, three horses being used.

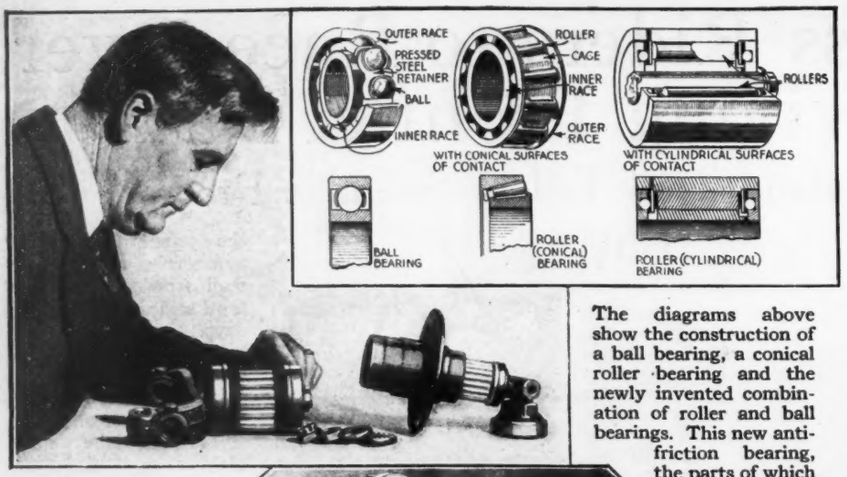
Riders carried the mails in two water proofed leather pouches, one swung in front and the other behind. Only letters written on the thinnest tissue paper were accepted, and the first postage rate charged was $5 an ounce. It was not exceptional for a single letter to carry $25 in postage, and for the two packs of the rider to contain mail representing postage of many thousand dollars.

"Buffalo Bill's" Long Ride

The longest ride ever made in the Pony Express service is credited to Buffalo Bill. When a lad of 14, he made a run of 384 miles through hazardous Indian territory, going on and on because his relief rider had been killed by Indians. This was four miles farther than the longest ride of "Pony Rob" Haslam, who made the fastest time on record—eight hours and ten minutes for 120 miles.

In conjunction with the Mark Twain celebration, Admission Day and the 75th anniversary of the discovery of gold in California will be observed. The American Legion convention in San Francisco and a rodeo at Reno occur at the same time.

With the varying activities of these events, westerners expect to present to the Eastern visitor a vista of the West of romance, at the same time showing scientific progress made by the settled West of today.



The diagrams above show the construction of a ball bearing, a conical roller bearing and the newly invented combination of roller and ball bearings. This new anti-friction bearing, the parts of which are pictured at the left, has been run 20,000 miles on an auto without the use of oil

Anti-Friction Roller Bearing Needs No Oil

AN ANTI-FRICTION roller bearing, which, it is claimed, may be used indefinitely without lubrication, recently has been invented by a New York engineer. The inventor asserts it is 70 per cent more efficient than any type now on the market.

The new bearing combines the roller bearing and ball bearing principles. It consists of a straight sleeve which fits over a spindle, axle or shaft, and contains two sets of straight rolls, bearing rolls and spacing rolls. The bearing rolls carry the weight, while the spacing rolls or idlers, reduced to a smaller diameter, alternate and revolve in a direction opposite to that of the bearing rolls.

Side thrusts are taken up by rotating balls acting between disks and ball retainers, while bearing pressure acts on the rollers. As all parts are rolling there is no sliding and no necessity of lubrication.

The single bearing shown has been run 20,000 miles with no sign of wear.

New Flashless Gunpowder

THE War Department has just announced the successful development of a new powder for use in small arms and artillery. It is said to possess all the driving power of the type now in use, and at the same time it is smokeless, flashless and impervious to moisture. It will permit night firing without revealing the position of guns.

Typewriter Carbon Paper Handled Automatically

IN a new device for conserving the carbon paper used in making "second sheets" on a typewriter, the letter-head and second sheet are placed in the machine, and the carbon paper is fed between them automatically from the roller above.

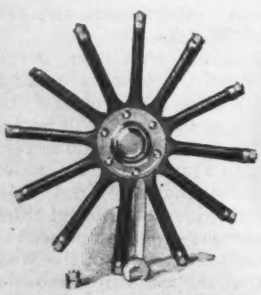
When a sheet is finished original and copies are removed simultaneously, leaving the carbon paper wound about the platen.

Carbon paper is fed from roller

Knock-Down Wheel for Quick Tire Changing

A NOVEL automobile wheel that will enable the motorist to change a tire—tube and shoe—in not more than 10 minutes, and with no other tool than a small steel wrench, recently has been constructed.

Nuts threaded to the ends of the spokes hold the steel rim in place. When these are loosened, the rim may be removed, collapsed by the turn of a lever and the tire changed. A movement of the same lever makes the rim rigid when the new tire has been placed about it. Then the tire is pumped up immediately and the rim placed back on the wheel.



Wheel with rim removed

How the rim collapses

The new tire in place

Toothed Jaws in Vise Hold Round Stock

TO THE handy man about the workshop at home there come times when it is necessary to hold some round stock in a vise; yet the occasions for this sort of work are so few as to make it impracticable to own an expensive pipe vise.

The device shown in the illustration below slips into any wooden or iron vise, and will grip and hold almost any size of round stock. It consists of two pieces of steel, concave and toothed on their inner faces and joined by a strip of spring steel which allows them to be brought close together or spread far apart.

How the toothed jaws fit into home workbench vise, and hold round pipe for cutting

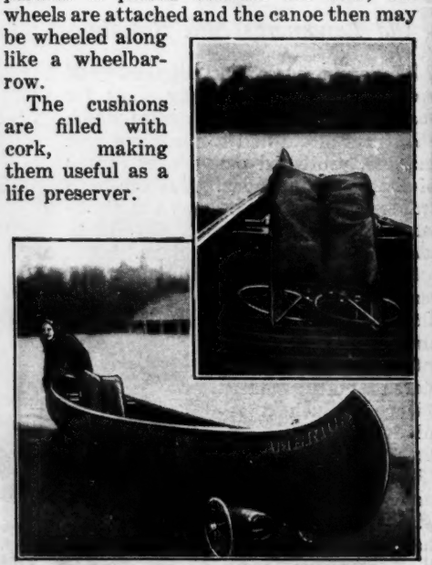
"Stainless Silver" Discovered

A NEW tarnish resisting alloy, called "stainless silver" recently has been discovered as the result of research in the laboratory of a firm in Sheffield, England.

Canoe Carrier Folds Into Cushioned Back Rest

AN INGENIOUS accessory for a canoe combines a wheeled carrier for use in making portages, a back rest for paddling, and a life preserver in case the canoe should upset. The cushioned device is fitted in the canoe as a back rest. When it is necessary to transport the canoe over land, the apparatus is placed beneath the bow, the wheels are attached and the canoe then may be wheeled along like a wheelbarrow.

The cushions are filled with cork, making them useful as a life preserver.

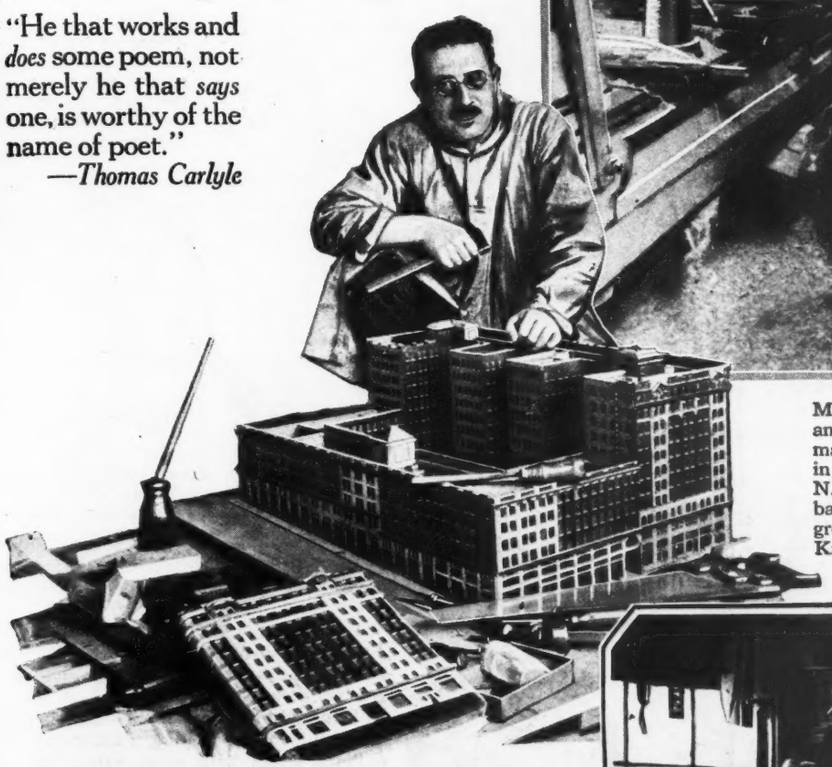


The folding device used as portage carriage and as cushioned back rest

Interesting People and Their Work

"He that works and *does* some poem, not merely he that *says* one, is worthy of the name of poet."
—*Thomas Carlyle*

MAKING BLUDGEONS FOR BABE RUTH and other famous home run hitters of the major leagues is the pastime of Joseph G. Kren in a little shop back of his home in Syracuse, N. Y. The wood he uses in turning out baseball bats for noted sluggers is second year growth ash, sun dried and weather cured. Kren is shown above at work in his shop



BUILDING TOYS IS HIS HOBBY. F. Tadema, one of America's most famous oil and watercolor artists, is shown above with a miniature of the White-Henry-Stuart building, Seattle's largest business block, which he is constructing with simple tools

A DECOY ARTIST is Elmer Crowell, whose workshop is in the tiny hamlet of East Harwich on Cape Cod. His skill in duplicating the bodies of birds in wood and coloring them has won for him a national reputation among sportsmen. No two decoys that he makes are alike

THESE TWO LOCOMOTIVES WERE BUILT OF SUGAR by Joseph Sommers, head pastry chef of the Hotel Astor, New York City, to adorn the table at a recent 100th birthday banquet of the Delaware & Hudson Railroad. The chef is shown above with his sugar models of the old and new in locomotives. Note how intricate parts of the engine are reproduced in detail

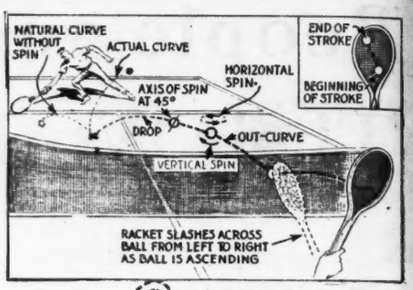
Mechanical Kinks of Tennis

How Racket Experts, by Mastering Simple Principles of Physics, Have Won World Supremacy on Courts

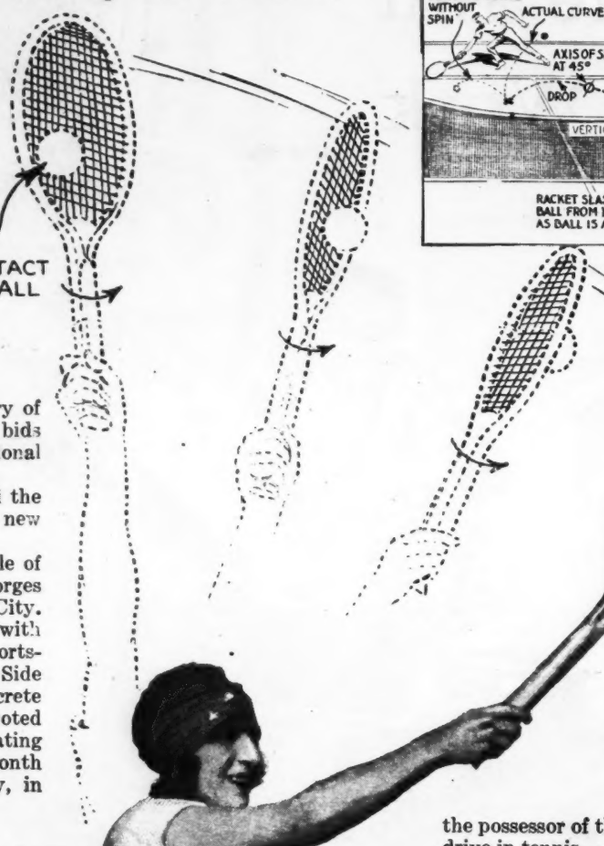
By William H. Keats

MR. KEATS, one of the editors of the New York Sun, learned his tennis from a book on mechanics. Although he started to play the game after he was 30 years old, he has mastered it to such an extent that he now is rated as an exceedingly skilful player.

He has witnessed every important tennis contest at Forest Hills, Long Island, the tennis Mecca of America. What he says in the following article about the mechanics of the game comes with the authority of an expert.



Mechanics of the American Twist service stroke. Slashing of the racket across the ball produces a double spin curve and a baffling bound



In the American Twist service, the racket moves across the ball from bottom to top and from left to right, as shown here. Arrows indicate twist of racket

THIS is the greatest season in the history of American lawn tennis—a sport that bids fair to rival baseball and boxing in national popularity and in world supremacy.

In baseball, 72,000 fans this year witnessed the opening American League game in the huge new stadium of the New York Yankees.

In boxing, 90,000 spectators saw the "battle of the century" between Jack Dempsey and Georges Carpentier at Boyle's Thirty Acres in Jersey City.

And now comes tennis, to thrill vast crowds with amazing exhibitions of scientific skill and sportsmanship. At Forest Hills, L. I., the West Side Tennis Club is completing a great bowl of concrete and steel—the first stadium in America devoted exclusively to tennis—with a capacity of seating 20,000 spectators. Here will be played this month the challenge round of the Davis Cup play, in which challengers of 18 nations will compete.

Science Wins for American Athletes

Americans rule supreme in boxing, baseball and tennis. Why is this?

Simply because we are a nation of specialists. We put more brains, more psychology and more science into our play than any other people.

No game affords a better example of this application of science than tennis as it is played by stars of to-day. They look upon tennis as a game of dynamic mechanics, and they study and play it on that basis.

Kinetic energy, momentum, gravity, ballistics, elasticity, rotation, motion of translation—these terms sound like a list of chapters in a textbook of physics. Actually they are a concise compilation of the most important principles of tennis; principles that must be understood and mastered by any one who would excel in the game.

The truth of this statement was demonstrated remarkably at Forest Hills last September when William M. Johnston, of San Francisco, who recently won the world's singles championship at Wimbledon, England, met and defeated Gerald Patterson, of Australia, in the Davis Cup finals. In that game Johnston set a high water mark for mechanics and science as applied to sport. The little Californian played with such marvelous precision and mechanical accuracy that spectators almost thought he controlled the ball by means of an invisible string.

On one side of the net towered the powerful Patterson, grim and determined, as he boomed his shots over the net at tremendous pace.

On the other side of the net was "Little Bill" Johnston, quiet, cool and pale, yet brisk and businesslike in all his actions—the possessor of the most scientific forehand drive in tennis.

When the play began it seemed to me, as I sat in the grandstand, that the American could not possibly stand up before the Australian's great speed and terrific service. But Johnston soon dispelled my doubts of his ability by returning Patterson's most difficult shots with ease, often for clean passes or placements.

In the end the Australian, although he possessed a world of speed and splendid control, was beaten by the one-sided score of 6-2, 6-2, 6-1. Science and a superknowledge of the mechanics of the game had triumphed for the American star.

The secret of Johnston's success is *control* of the ball, and the secret of control is *spin*. Control is just as important in tennis as it is in baseball. But the tennis player can stroke curves that no pitcher can pitch. In the so-called American Twist service, for example, the ball curves three ways. As it leaves the server's racket it first describes an outcurve; by the time it has reached the net it has become a drop, and the bounce becomes an outcurve again. This wonderful service has revolutionized tennis.

Maurice E. McLoughlin, "The California Comet," and National Singles champion

Mlle. Suzanne Lenglen, the French girl tennis wizard, who holds the world's championship in women's singles, completing a service stroke

Gerald Patterson, Australia's New Star

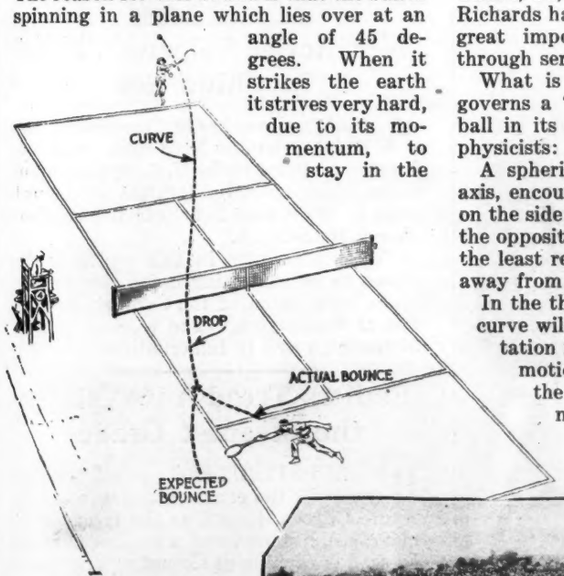
"Bill" Tilden, 2d, National Champion

Mrs. Molla Bjurstedt Mallory, American Women's Singles Champion

"Little Bill" Johnston, of California, who recently won the world's singles championship

in 1912 and 1913, was the most successful exponent of this stroke. In his own words, this is how he does it:

"Mechanically speaking, the whole explanation of this service is that the axis on which the ball spins is tilted over at an angle of about 45 degrees. In the 'American Twist' this is produced by the racket moving across the ball both from bottom to top and from left to right at the same time. The ball thus has a forward spin, from server to receiver, and also an impetus from left to right which makes it rotate on an axis tilted over as stated. From the server's point of view it swerves in flight from right to left, but 'breaks back' on the bound from left to right. The receiver sees it curving, naturally, from his left to his right and is surprised that it 'breaks' directly opposite. The reason for this bound is that the ball is spinning in a plane which lies over at an angle of 45 degrees. When it strikes the earth it strives very hard, due to its momentum, to stay in the plane of its rotation. Also this ball takes an erratic curve upon breaking, and is particularly hard to meet squarely with the racket."



The baffling effect of the revolutionary American Twist Service stroke is shown above. Leaving the server's racket, the ball describes a curve and drop. The receiver sees it curving and is taken by surprise when the ball, on the bound, suddenly breaks in the opposite direction. The reason for this bound is that the ball spins in a plane that lies over at an angle of 45 degrees

The mechanical secret of the remarkable control that is possible with this service is the *prolonged* contact of the racket with the ball. The ball, which is thrown above the head and a little to the left, is struck a glancing blow while it is still traveling upward. At the same time the racket is wiped across the ball from rim to rim, left to right.

Service Stroke Highly Important

Once service was utilized merely to put the ball into play, but to-day service as played by Johnston, Patterson, William T. Tilden, 2d, R. N. Williams, and Vincent Richards has become an offensive stroke of great importance. Indeed, one break-through service means winning the set.

What is the underlying principle that governs a "topped" or "undercut" tennis ball in its flight? Here is the answer of physicists:

A spherical body, rotating on its own axis, encounters more resistance in the air on the side that is moving forward than on the opposite side, and in seeking the line of the least resistance it is depressed slightly away from that direction.

In the theory of rotation, the maximum curve will be reached in a ball whose rotation is exactly equal to its forward motion. The back-spinning side of the tennis ball will encounter more or less friction, according to how much its speed around its own axis is greater or less than its speed in forward motion.

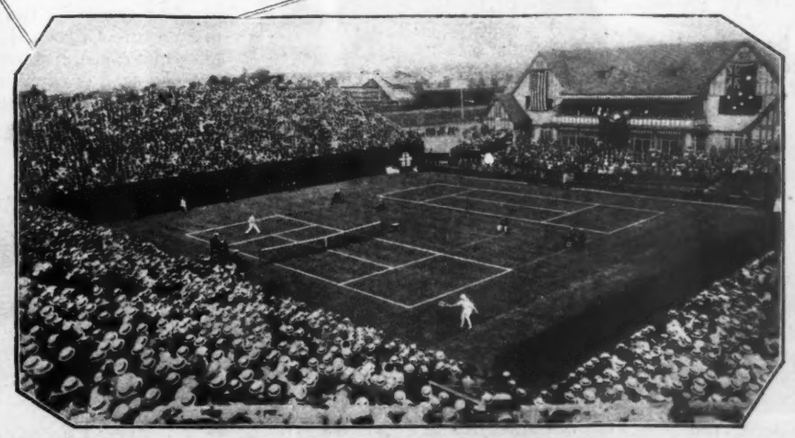
Another stroke that is as important in tennis as the curved ball is in baseball pitching, is called the Lawford stroke, discovered by an Englishman whose name it bears. This is the fundamental stroke of good tennis everywhere. It is a "topped" ball. That is, it travels with over-spin and its action is the same as a pitcher's drop. The twist is given to the ball by a sharp upward glancing blow, the racket and arm following through and finishing high, on a level with the shoulder. No other stroke permits the player to exert such drive and still keep the ball in court. Another advantage is that on account of its spin it is an exceedingly difficult stroke to volley. Tilden, Johnston and Williams put less top on their forehand drives than do McLoughlin and the two Japanese experts, Kumagae and Shimizu. Kumagae is noted for the accuracy and severity of his Lawford.

One of the secrets of Johnston's amazing skill is his forehand drive, which is the fastest and most perfect stroke of its kind in the world. His racket follows through on the ball like the lash of a whip, and finishes around his body.

"Follow Through" Is the Secret

Tilden, Mrs. Molla Bjurstedt Mallory, and Mlle. Lenglen, in giving mechanical twist to the ball, follow through to such an extent that the racket and arm wrap around the body. Kumagae, who is left handed, not only follows through, but his racket travels with such great speed and freedom that it finishes high over his head and describes two complete circles at the end of his stroke! As in baseball, golf and billiards, the "follow through" is the most important secret of successful tennis playing. It is the "follow through" of the racket that puts spin on the flying sphere and it is this spin that gives control.

In other words, success in mastering the game of tennis depends largely on the skill in which the fundamental principles of mechanics are applied at the moment when the racket strikes the ball. It is the study and application of these principles that makes world's champions.



The decisive Davis Cup Match between William M. Johnston, of California, and Gerald Patterson, of Australia, at Forest Hills, L. I.

Roller Skate Sailing New Sport in Germany

SAILING before the wind on scooter-roller skates is a new sport that has become popular on the streets and in the parks of Berlin, Germany, where it was introduced by an English inventor.

The skates are made of light metal and have extremely large rubber-tired wheels, resembling the "scooters" so popular with American children. The skater stands on a small platform slung between the wheels, and the skates, strapped to his feet, are braced half way up the leg.

The light triangular sail is made by stretching canvas on a bamboo frame. In a stiff breeze a speed of at least 30 miles an hour is possible.

Speeding with the wind, two roller skaters are propelled by one sail

Tiny New Animal Swims in Drop of Water

A MICROSCOPIC animal about one two-hundredth of an inch long has been discovered by L. L. Woodruff, of Yale University, who has named it "Paramecium polycaryum." It is one of the one-cell forms known as protozoa. It moves about rapidly in a drop of water and feeds on bacteria.

Strange Fishing Boat Made of Odds and Ends

BY UTILIZING all manner of odds and ends such as can be found about almost any machine shop, an Italian workman has constructed a strange looking craft with which he glides along the Po River in Italy.

The boat is steered by means of a bicycle handle connected with the rudder. With his feet the operator turns the propelling paddle wheels.

A net suspended from a boom is raised and lowered by means of a rope that passes over a hand operated pulley.

Made of machine shop junk, this novel boat is propelled by foot power

World's Largest Bass Drum Taller than Drummer

THE largest bass drum in the world is eight and one half feet in diameter—taller than the drummer who plays it.

The instrument is constructed on the design of a smaller bass drum, from which it differs only in its proportions.

To transport it along the street in a parade, the drum is mounted on a small carriage with heavy rubber tired wheels. As it is pulled along, the drummer pounds out a tune.

Pocket Movie Camera Holds 81 Feet of Film

THE development of small movie projection for home use has led recently to the perfection of a pocket movie camera, ideal for taking cinema photographs on the automobile trip.

The camera holds 81 feet of film, and is said to produce motion picture photographs as perfect as do the movie cameras of regulation size.

Above, Miss Rose Sturtz is shown demonstrating the new camera at the International Photographic Arts and Crafts Exposition in New York City.

New Aerial Camera Takes Ten-Mile Picture

LIEUTENANT G. W. GODDARD, of the United States Army air service, is shown below with the new aerial camera which he has invented and which he tried out successfully in a recent flight in the vicinity of Los Angeles, Calif.

The new camera is for mapping purposes. It automatically makes successive exposures of uniform size on a film 390 feet long and six inches wide. The resulting pictures are joined together, as in ordinary aerial photographic work, to make a topographic map. From a height of 16,000 feet a strip of land 10 miles wide can be photographed in a single exposure, enabling the operator to map more than 1000 square miles in a couple of hours. The entire outfit weighs 100 pounds.

Lieut. Goddard's aerial camera "shoots" pictures through the floor of the plane

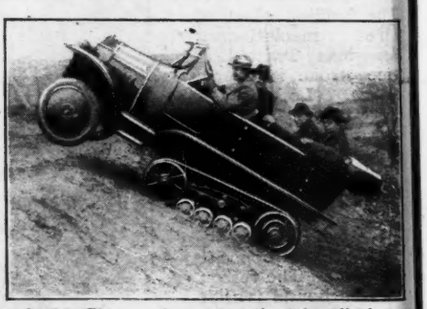
New Active Volcano Found in China Sea

A NEW volcano has just been born. Preliminary reports have been confirmed by recent advices to the U. S. Hydrographic Office which gives the location of the volcano in the China Sea near the coast of French Indo-China.

Volcanic activity in this region is declared to be something quite new by Dr. H. S. Washington, of the Carnegie Institution of Washington. The volcano is now 97 feet high and in full eruption.

Endless-Tread Auto Climbs the Steepest Grades

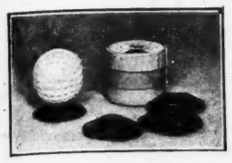
BY SUBSTITUTING small endless treads for the conventional rear wheels, Andre Citroen, known as the Henry Ford of France, has produced a motor car which he says is capable of ascending any grade less steep than the side of a house.



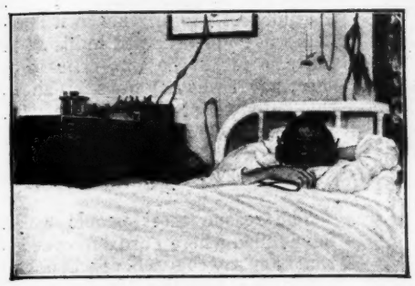
Andre Citroen demonstrating the climbing power of his endless tread auto

Paper Tees Aid Golfer to Drive Accurately

EVERY golfer can afford to have his practice fling with these tees made from paper. The tees are made from stiff paper, and are so inexpensive that the golfer will not mind hitting them into space and losing them. They hold the ball always at the same height, thus assuring uniformity in the drive, provided, of course, the stroke is always the same.



High School Boy Graduated by Wireless

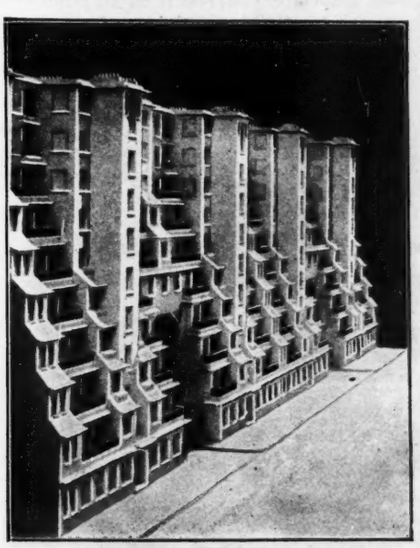


THE distinction of being the first student in the United States to be graduated by radio goes to Lester Picker, of San Diego, Calif. Confined to his bed by injuries and unable to attend his high school commencement exercises, he broadcasted his graduation speech from his home.

A receiving set with loudspeaker attachment, set up in the school auditorium carried his speech to the entire audience.

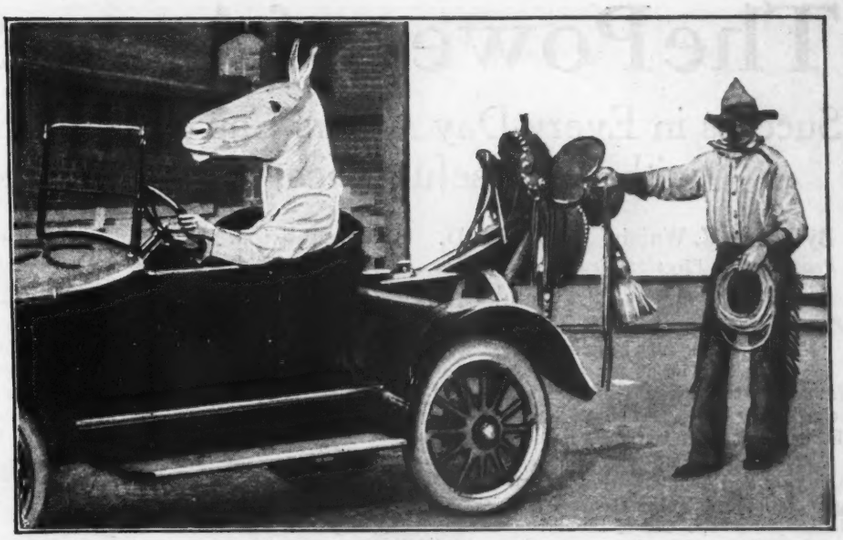
Terraced Apartment House Planned by Architect

A FRENCH architect's design of the apartment house of the future calls for a structure 10 stories high, built in receding terraces so as to afford light and air to every apartment. The three lower floors of the house are to be occupied by a gymnasium, a swimming pool and other health and amusement facilities.



© *Courtesy Building Age*

Ten stories in receding terraces, will permit plenty of light and air



Bucking Auto Imitates a Broncho

A BUCKING automobile which accurately imitated the actions of a lively bronco was exhibited recently at the National Western Horse Show in Denver, Colo. Bounding around the arena, the car at times lifted all four wheels in the air and came back to earth with a bang that resembled the attempt of an unbroken filly to throw its rider.

The bucking action was produced by using wheels with eccentric hubs. Each hub was three inches out of center, giving the car an up and down motion as it covered the ground. Since the wheels were not connected they seldom moved in the same phase and so imparted queer motions to the car. Whenever the wheels became synchronized, the auto was thrown violently upward, causing all wheels to leave the ground.

On a saddle fastened to a strut in rear of the car sat the buckaroo who experienced all the varieties of jolts that any horse could have given him.

Prize Winning Bird Gives Concerts by Radio

FRANK ZAGER, of Chicago, is shown above persuading "Baby Grand," his prize-winning radio canary, to sing over the telephone. Long distance singing is no new feat for Baby Grand, which more than once has given radio concerts from Chicago broadcasting stations. Zager has trained the bird so perfectly that it will sing at command, a fact that was most important in maintaining the time schedules at the radio stations where it performed.

Zager breeds canaries as a hobby, often having several hundred in the attic of his home. He does not keep them in small cages, as is the usual way, but gives them relative freedom in large flying coops. The sturdiness which his birds develop from the resulting exercise, he says, is largely responsible for their ability as songsters. Birds from Zager's cages have taken first prize in the Chicago show for the last two years, winning over 1,500 warblers.

The World's Most Powerful Machine Gun

THE most formidable enemy of the airplane that has been developed is the new .50 caliber Browning machine gun, shown below. This weapon is the most powerful machine gun ever perfected. It fires a bullet weighing a quarter of a pound, and will fire 500 shots a minute.

The maximum range of the gun is 9000 yards, or about 5 miles, and the caliber is such that one hit will destroy an airplane two miles away.

The anti-aircraft tripod used will permit the gun to be swung through 360 degrees, and elevated from 15 degrees below the horizontal to a vertical position.

The new machine gun on tripod, elevated for action against an airplane

The Power of Auto-Suggestion

Success in Every-Day Affairs Can Be Won by Bombarding the Mind with Purposeful Ideas; How Ford and Marconi Did It

By James J. Walsh, M.D., Ph.D.
Professor of Physiological Psychology, Cathedral College, New York City

THIRTY years ago Henry Ford completed his first gasoline engine after working on it for two years. He found the thing would run when mounted in a buggy, but it wouldn't back up. So Ford laid it aside temporarily.

But for two solid years he kept thinking and believing that an engine capable of going forward and backward at the will of the driver was possible and that he could build it.

In 1895 he went to work on his second gas engine. He had nothing to guide him but his own brain—and his brain, like every man's, resisted new ideas. He had to build and invent at the same time. Many times he seemed to be at the end of his resources, but he stuck to his idea and after three years completed the engine he had visualized—one that would go forward and backward. So was born the Ford automobile.

Why Henry Ford Succeeded

"This thing can be done," he kept saying. "I am doing it. I shall keep at it."

And this year the Ford plants are turning out something like 1,500,000 cars!

Henry Ford's career is the most striking example of auto-suggestion I know of. He had been called crazy. When he completed his first engine and found it unsatisfactory, he was confronted with what would have been insurmountable obstacles to most of us. Balked in his purpose temporarily, he kept thinking "It can be done," and that thought carried him through all barriers; especially through his own mental barriers, which insisted there was no solution of his problems.

For auto-suggestion, which is merely self-suggestion, means simply the ability to impress an idea on the mind, and through the mind on the will. It means impressing that idea *underneath* the ordinary barrier of opposition raised against the entrance of new impressions.

All of us are born with what has well been called negativism. Tell a child to do something and it will balk at once. We are willing to do the things that we ourselves think about, but when other people offer ideas we do not care to accept them until we have thought about them. This natural barrier against acting out the thoughts of others works very effectively. It is Nature's way of protecting us until we have given a proposition due consideration before acting.

Henry Ford stands today as one of America's most striking examples of the power of auto-suggestion to accomplish. "The thing can be done. I am doing it," repeated Ford nearly 30 years ago. This year his plants will turn out 1,500,000 cars

Advertisers know that if you say a thing often enough, people finally will act upon the suggestion. M. Coué urges his patients to say to themselves in the early morning and late at night, "Every day in every way I am getting better and better." This repetition gets the idea into the mind in such a way that it can be acted upon.

Ford's problem was to get the idea of his gas engine impressed on his mind strongly enough to make him exert more effort of will than he ever thought he had. He did it, and by succeeding in this first effort, trained himself for meeting and conquering future problems. The value of this early training in self suggestion was demonstrated dramatically when in 1920 and 1921, with assets of only $20,000,000 apparently available, he was called upon to produce $58,000,000 forthwith. Everyone knows of the remarkable fight that followed and of his final success in keeping the grip of Wall Street from his business.

"I will run my own business," Ford repeated. And he meant it.

Auto-suggestion, either conscious or unconscious, carried him through. The idea of running his own business was so firmly fixed in his mind that, so far as he was concerned, there never was any question about the outcome of his struggle with Wall Street.

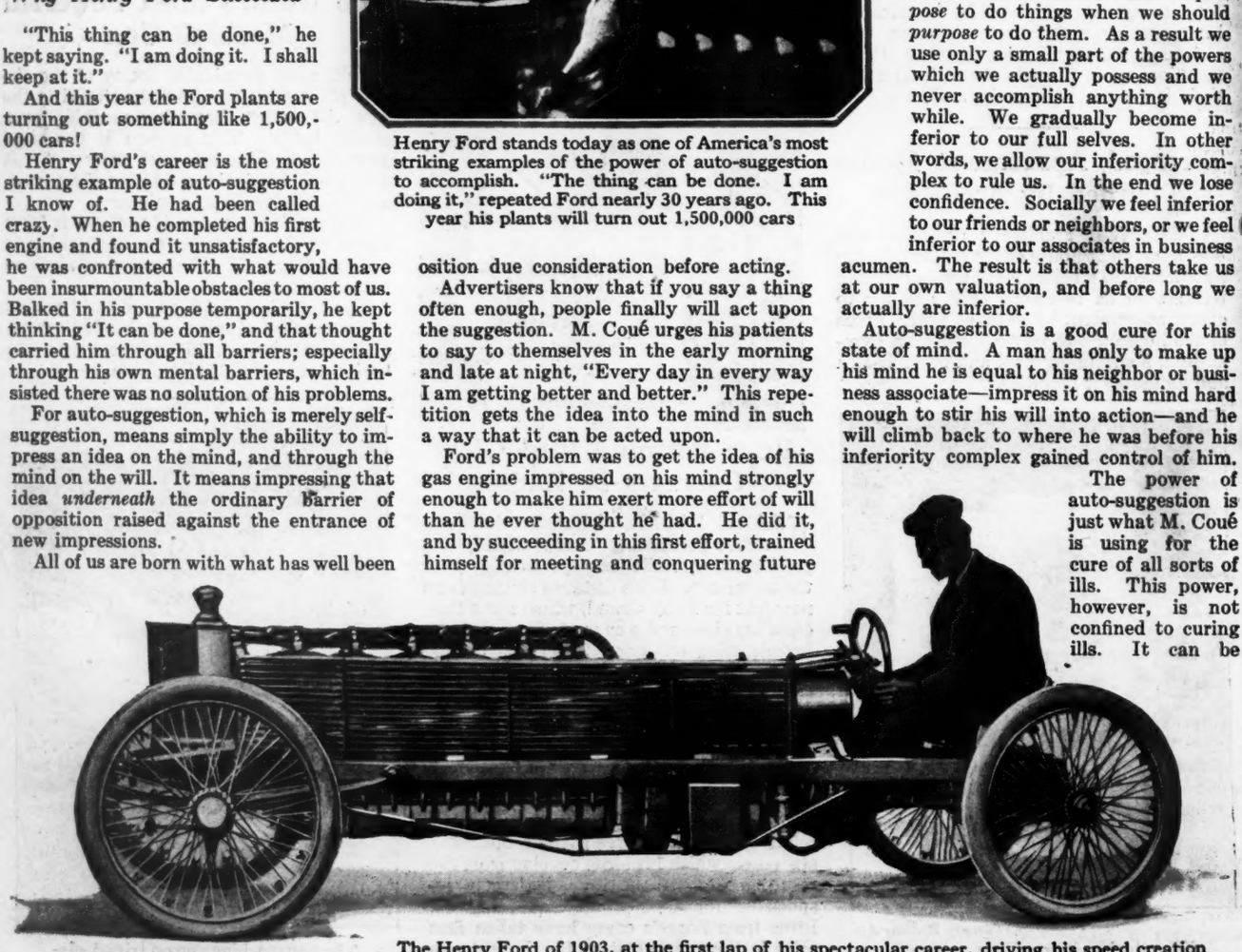
The Habit of Failure

The reason most people would have failed where Ford succeeded is that they say they will or will not do something, with the mental reservation that probably they will not be able to accomplish their purpose.

When a person says "I'll try," failure already is in sight. In most of us it has become a habit to *propose* to do things when we should *purpose* to do them. As a result we use only a small part of the powers which we actually possess and we never accomplish anything worth while. We gradually become inferior to our full selves. In other words, we allow our inferiority complex to rule us. In the end we lose confidence. Socially we feel inferior to our friends or neighbors, or we feel inferior to our associates in business acumen. The result is that others take us at our own valuation, and before long we actually are inferior.

Auto-suggestion is a good cure for this state of mind. A man has only to make up his mind he is equal to his neighbor or business associate—impress it on his mind hard enough to stir his will into action—and he will climb back to where he was before his inferiority complex gained control of him.

The power of auto-suggestion is just what M. Coué is using for the cure of all sorts of ills. This power, however, is not confined to curing ills. It can be



The Henry Ford of 1903, at the first lap of his spectacular career, driving his speed creation in which he won a thrilling race with the car of Alexander Winton in Detroit

Repeating to himself that he is master of beasts, the animal trainer gains real mastery which, reflected in his face and movements, finally convinces the animals of its truth

applied to all the ordinary affairs of life. Just keep telling yourself that you can do something and after a while you will be able to do it, if it is not entirely beyond your natural powers.

It was Guglielmo Marconi's habit of thus telling himself that he could send messages through the air without the use of wires that is responsible for wireless telegraphy and its offspring, radio.

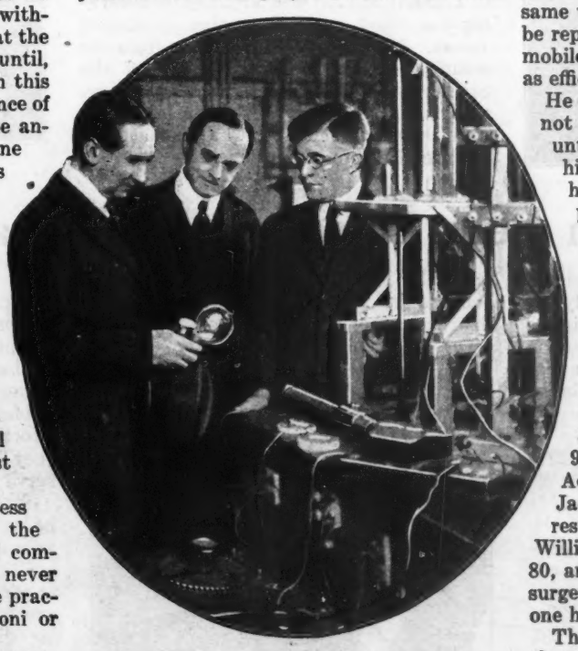
When Marconi, at the age of 16, began to experiment with wireless, he was convinced that wires were not necessary in the transmission of messages. For five years he tried to put his theories into practice, without success. But he kept thinking that the thing was possible and worked along until, in 1895, he got his first patent. With this early apparatus he could cover a distance of two miles. He was ridiculed when he announced he could send messages nine miles. His native country, Italy, was not interested in his work and he met every possible discouragement in developing his apparatus. But he kept telling himself he would succeed because he knew he was right.

Finding that he could get no support at home he took his theories and apparatus to England in 1896, and the next year succeeded in sending messages 12 miles. In 1898 he extended his operation to 32 miles and on December 12, 1901, flashed the first message across the Atlantic.

In 1908, when transatlantic wireless stations were opened for business, the world accepted the new method of communication as a matter of course, never stopping to think of the innumerable practical difficulties overcome by Marconi or how he overcame them.

To most people it seems an almost childish idea that you can just repeat something and have it produce ever deeper and deeper influence, but it is literally and practically true. The average animal tamer mentally repeats over and over again that he is master of the beasts and so gets to know it is true. And this gives him the determination which, reflected in his eyes, convinces the animals he is their master.

Some men, lacking confidence, wake in the morning with a tired feeling, reasonably sure that they will not be able to accomplish much that day. And of course, they fail to accomplish. A man who fails to begin the day by saying to himself "I will do to-day what I was not able to do yesterday," has not the heart to tackle his job properly. But if he has confidence in himself, it makes his work easier until it becomes a pleasure instead of drudgery. Further, he learns he has individuality. Many of us never learn this. We do things in the conventional way because we are afraid to be "different;" afraid we will be laughed at if we allow our personalities free play. That is a fatal mistake. What if Marconi had succumbed to ridicule?



Less than 30 years ago Guglielmo Marconi was ridiculed when he announced he could send messages two miles by wireless. Today, with the success of radio assured, he has just announced the perfection of a new method for transmitting messages up to 2500 miles not only with a very much smaller amount of power and energy, but also faster and more cheaply than the ordinary systems of long-distance wireless. Senator Marconi is shown above inspecting a powerful new vacuum-tube

I know an accountant who has risen high in his profession. He once told me that he started as a clerk in the offices of a large corporation which had hundreds of employees such as he. They were as much alike in their duties, habits and dress as peas in a pod. He was in a fair way to become established in this class. Then he took inventory of himself and his job. He discovered that the reason he was getting $18 a week, the same as the others, was because there were so many thousands doing the same work in the same way that he could be replaced at any time, much as an automobile part can be replaced, by a man just as efficient as he.

He said to himself, "I'm different. I will not be the same." He kept thinking this until he firmly believed it; then he quit his job. With confidence strong in him, he reached for a higher position in his profession and got it. He has been advancing ever since.

Some persons who are afraid that strenuous effort will shorten life, could allay their fears by reviewing the lives of some of our great physicians.

I made it a point 25 years ago to know well half a dozen of the older men who were great workers in New York medicine. Among them were Stephen Smith who died at the age of 99 years and eight months; Thomas Addis Emmet, who died at 93; Abraham Jacobi, who was nearly 90 when the result of an accident took him away; William H. Thomson, who was well above 80, and J. W. S. Gouley, the distinguished surgeon, another of the octogenarians. Each one had been an intensely hard worker.

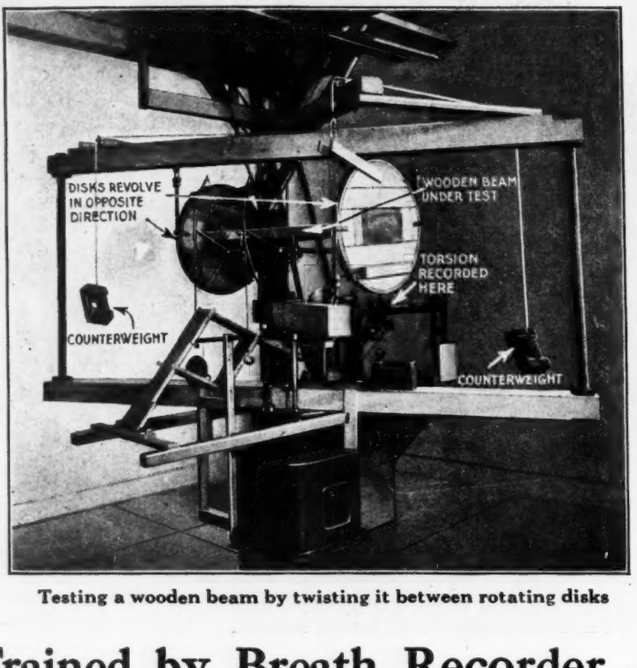
These men gave themselves suggestions that warded off tiredness. They pushed through the barrier of beginning tiredness and used up the sum of their energy. Instead of exhausting themselves, they broadened life and made themselves more capable, not only of greater work, but actually of longer life.

IS YOUR memory poor? Next month Doctor Walsh will describe in detail a series of simple daily exercises—a "daily dozen" for the mind—that will help you overcome this serious handicap.

Torsion Machine Tests Wooden Beams

TO OBTAIN exact information as to the strength of wood used for such purposes as rudder posts, elevator spars and aircraft beams, the U. S. Forest Service has constructed an unusual torsion testing machine in its laboratories at Madison, Wis.

The wood to be tested is fastened securely between two large disks, which are made to revolve in opposite directions, twisting the specimen under test. The amount of torsion, or twisting strain, which the wood will withstand is recorded in terms of inches or degrees of arc.



Testing a wooden beam by twisting it between rotating disks

Phonograph "Silencer" Filters Out Scratches

AN INGENIOUS "silencer" for phonographs has been put on the market recently by a Texas manufacturer. As shown in the illustration, the device is inserted between the needle and the reproducer.

Its design and materials are such that it filters out the scratching of the needle on the surface of the record, it is claimed, while reproducing the record with unimpaired volume and a sweet and natural tone. It may be attached to any make of talking machine using needles.

Uncle Sam Tags Fishes to Trace Migrations

TO TRACE the migrations of fishes in the oceans, the Federal Bureau of Fisheries has marked with metal tags about 10,000 cod, pollack and haddock. Discoveries about fishes' habits are expected.

Marking a fish with metal tag

Voices Trained by Breath Recorder

A BREATH recording machine designed to teach actors, singers, and orators to sing or speak correctly and with maximum conservation of energy, has been invented by a Viennese opera singer.

An oscillating plate is suspended within a small horn, similar to the mouthpiece of a telephone transmitter, in such a way that it will vibrate when the sound waves of the voice are directed against it. Vibrations of the plate are recorded by the movements of a needle on a dial, but the apparatus is so arranged that there is no movement of the needle if the breath is used correctly.

This adjustment was obtained by observing the effect on the machine of trained voices. Movements of the needle from the position of rest indicate the use of the breath in incorrect quantities. The person using the device perseveres with his efforts until the needle shows that he has mastered the use of his vocal equipment.

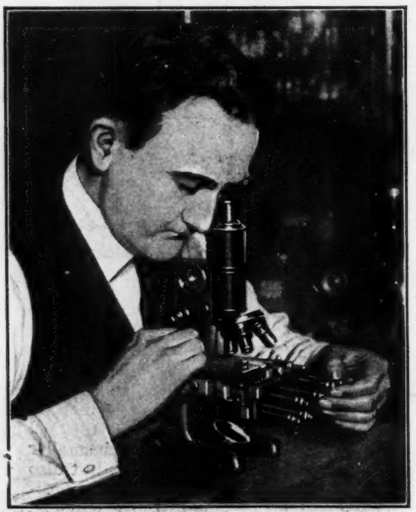
Living Human Cells Dissected in War against Disease

A FASCINATING field of science which is expected to lead to highly important discoveries in the war on disease has been opened recently by the perfection of an improved micro-vivisection apparatus with which living human cells, invisible to the unaided eye, can be dissected and studied.

The apparatus was developed by Professor C. E. Thoraldson, of the department of zoology of Northwestern University. It is of brass, small enough to be held in the palm of the hand. Micrometer screws control glass needles and pipettes which cut into a single living cell isolated in a drop of nutrient liquid under a microscope. The movement of the screws is measured in the thousandth part of a millimeter, yet it is always exact, controllable and free from vibration.

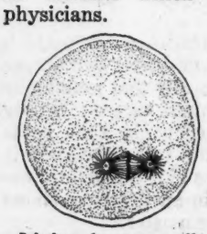
By his device, Professor Thoraldson says it is possible at last for scientists to remove certain portions of a living tissue cell and yet keep the remnant living, so that its subsequent development can be observed. Through pipettes or glass tubes, certain chemicals may be injected directly into the protoplasm of the cells and their effect studied under the microscope. The apparatus also is said to isolate pure cultures of bacteria by a much more rapid method than any other previously devised.

On the theory that once the complex basic cell could be broken up for study the functioning of the entire body could be better understood, scientists have attempted for more than a half-century to devise a means of dissecting a single living organism. Prior to the development of Professor Thoraldson's machine, their efforts were only partially successful and they had to content themselves with observation of dead and fixed tissues.

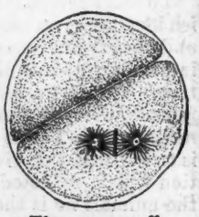


Prof. C. E. Thoraldson at work with his micro-vivisection apparatus

Since the functioning of a single cell may be taken as the key to all problems of animal or human conditions in sickness or health, scientists say that the Thoraldson apparatus provides means for research which may lead to the discovery of cures for diseases which always have baffled physicians.



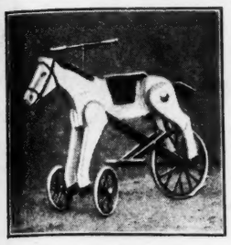
Living human cell under a microscope



The same cell, after dissection

Galloping Hobby Horse Is Propelled by the Feet

MECHANICS have entered the nursery and have made the time-honored hobby horse run with the speed of a bicycle while still maintaining life-like motion.



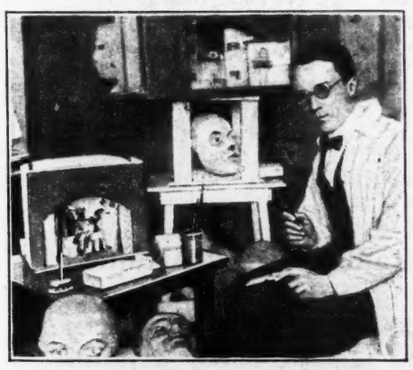
A large rear wheel is propelled by the rider as he bounces in the saddle, pushing down with his feet on the stirrups. The wheel is turned by a crank to which the wooden horse's hind legs are fastened. The weight of the rider's body, as he sits on the horse, forces the crank down, making a half turn of the wheel.

The stirrups are formed by a cross-bar beneath the horse. When the rider shifts his weight to this bar, a lever action forces up the rear of the horse, making the other half turn of the wheel. As the toy rolls along, its motion resembles that of a live horse.

Kettles Made from Pennies

USING United States one-cent pieces as their material, two sheet-metal workers in New York City recently held a contest to determine which one could hammer out the smallest kettle. The results of their handiwork are shown in the illustrations.

Two of the kettles are provided with tiny handles and with spouts that permit the passage of water. All three are so tiny that they can be held in the palm of the hand.



Rubber Masks for Actors Replace Stage Paint

INSTEAD of using paint, powder, lip sticks and eyebrow pencils to give definite character to the features, actors and actresses of the Staatstheater in Berlin cover their faces with thin flexible rubber masks representing the faces of the characters to be portrayed on the stage.

Since the rubber clings to the face, the mask moves with the wearer's features, producing smiles or other facial expressions.

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A Storehouse of Inventors' Ideas

IN THIS room are filed the thousands of applications for patents registered with the United States Patent Office.

As soon as an inventor sends in his application to the patent office, clerks go through the files in this searching room to ascertain whether or not application already has been made for a patent on the same device.

Radio Champion Hears 35 Stations in 24 Hours

IT ALWAYS has been a source of pride to be the only one in the world able to do something that no one else ever has been audacious, patient or original enough to do. As a result there are some very curious records.

In Paris, in 1809, the famous Danes, Baptiste and Francois, competed in a race on the Place de l'Opera, in which both of them walked on their heads.

The latest contest stunt is a "radio golf" endurance record established by Harold Stein of New York City.

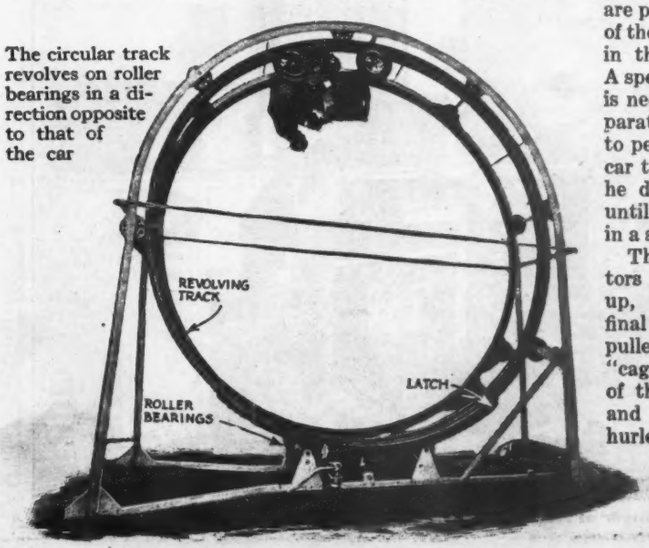
Sitting at his receiver for 24 hours, Stein brought in a total of 35 stations all over the U. S., Canada and Cuba with a total of 30,000 miles for the period.

Harold Stein, champion "radio golfer," lunches while he listens in

Auto "Squirrel Cage" Is New Thriller

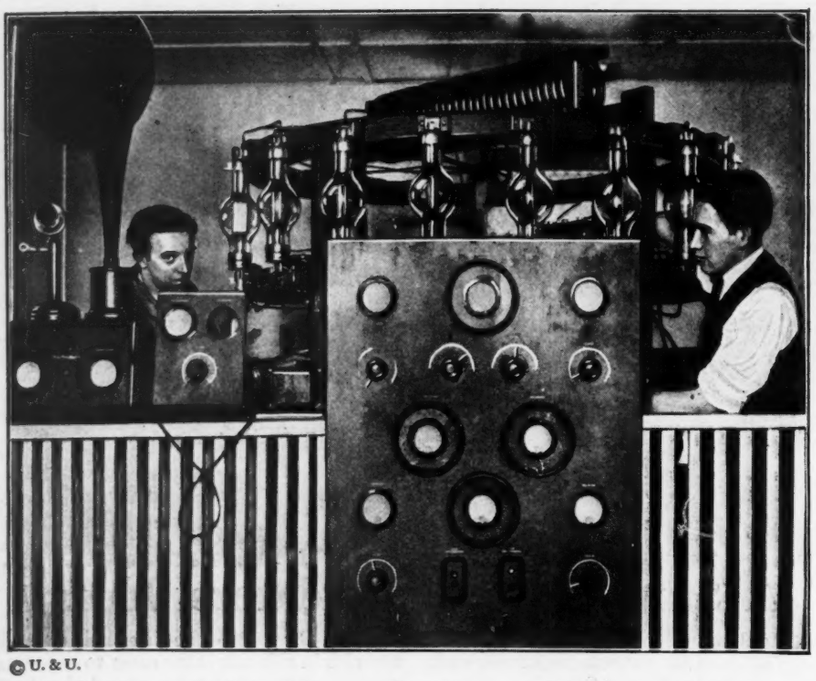
THRILLS a plenty are furnished for the spectator by the "Squirrel Cage," a new daredevil stunt now being performed in leading vaudeville theaters.

As the name implies, the idea of the new thrill producer is taken from the familiar revolving wire cylinder in which captive squirrels do their daily dozen. This human "cage," though, is a circular track of steel, 18 feet high, revolving on ball bearings when a tiny racing automobile is run within it. The revolutions of the "cage" are produced by the wheels of the automobile revolving in the opposite direction. A speed of 25 miles an hour is necessary before the apparatus moves fast enough to permit the driver of the car to loop the loop. This he does again and again, until the audience is held in a state of tension.



The circular track revolves on roller bearings in a direction opposite to that of the car

Then, when the spectators are sufficiently keyed up, they are given their final thrill. A lever is pulled which locks the "cage," the lower portion of the structure collapses, and car and driver are hurled into space. They are caught in a basket concealed from the audience in one wing of the stage.



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World's Most Powerful Broadcasting Station

HERE is the giant transmitter of the new WJAZ broadcasting apparatus at the Edgewater Beach Hotel, Chicago, said to be the most powerful radio station in the world. Programs transmitted by this apparatus can be heard everywhere in the United States. Reports have been received that the station's programs have been picked up at places 3,000 miles away.

This range of transmission is surpassed frequently, of course, by broadcasting stations near the coast, but a 3,000-mile range is extraordinary in a station located so far inland as Chicago.

The WJAZ studio is on the ground floor of the hotel and is walled by plate glass, permitting visitors to see how the broadcasting is carried on.

Radio Fan Installs $5,000 Apparatus at Home

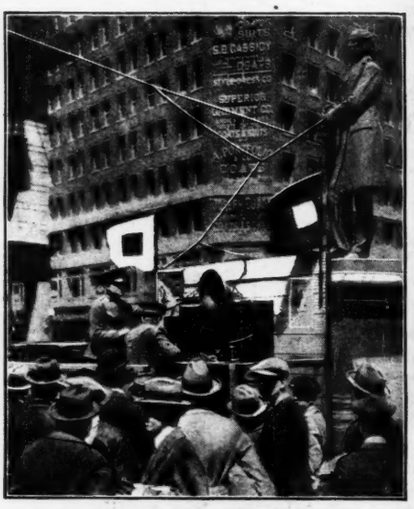
PROBABLY the most elaborate of all home radio outfits in America is that owned and operated by George Freisinger, of New York City, who has installed transmitting and receiving apparatus in his home. Being wealthy, he has spared no expense on his apparatus. He has spent to date more than $5,000 in fitting out his station, the call letters for which are 2-ABT.

Freisinger, who is a licensed operator, is shown below with his instruments. At the extreme left is a 300-watt transmitter, while mounted on the desk is a combination transmitter-receiver of the navy type, using 20-watt singer tubes for transmitting and a standard honeycomb regenerative hook-up with two stages of audio amplification for receiving. In the center is a special type of amateur receiving unit with two stages of audio amplification and at the right is a three-stage power amplifier.

George A. Freisinger of New York City, listening in with his $5,000 radio set

Plain Teacups Serve as Radio Amplifiers

AN INVENTIVE radio fan has devised a surprisingly efficient loud speaker from his head phones and a pair of tea cups, as shown in the photograph above. The head set is connected with the amplifier and each ear piece placed into a teacup. He reports that a clear, bell-like tone of astonishing volume is produced.



Loud Speaker Outfit Aids in Recruiting

RADIO as a stimulant to recruiting is being used with great success by the New York National Guard. The photograph above, taken at Thirty-fifth Street and Broadway, New York City, shows how it is done.

Music from the big loud speaker always can be depended on to attract a crowd; then, when the crowd is large enough, a recruiting orator mounts the rostrum and explains to the assemblage the advantages of National Guard Service.

Radio Secrecy Attained by "Scrambling" Device

ONE of the greatest problems of radio telephony—privacy of conversations—has just been solved by engineers of the Bell telephone system, through the invention of apparatus that is reported to have worked successfully over a 30-mile stretch of ocean between Los Angeles, Calif., and Catalina Island.

Radio secrecy has been obtained, through an invention that "scrambles" the conversation at one end and "unscrambles" it at the hearer's end. In other words, the radio talk becomes a jumble to any outside party who may try to listen in on the same wave length.

Around the Radio Circuits

with Jack Binns

Second Article: The Secrets of Reflex and Inverse Duplex

This is the second of a series of three articles in which Jack Binns, our radio editor, is reducing intricate radio circuits to first principles. Here he explains the fundamentals on which radio frequency and reflex circuits are based, and shows the relation existing between these supposedly involved circuits and the simple vacuum tube circuit

TO THE majority of radio fans, the mention of "reflex" and "inverse duplex" circuits conjures up visions of circuits hard to understand and still harder to design. As a matter of fact, these circuits can be mastered easily once the fundamentals are understood clearly.

In the simplest type of vacuum tube set there are three circuits as shown by A, B, and C in the schematic diagram in Fig. 1. A radio wave flowing in the A or primary circuit, produces by induction a similar wave in the secondary or B circuit which, through the amplifying action of the tube produces a similar wave of greater proportions in the C or plate circuit.

Whether the wave is amplified by the tube "as is"—that is, as an electromagnetic wave of high frequency and of an alternating character, or one of low frequency, flowing in one direction—depends on the adjustment of the movable arm of the potentiometer. This controls the characteristics of the grid current and the rectifying action of the tube, which serves as a detector.

In all the photo diagrams illustrating this article the tuning unit consists of honeycomb coils. Any form of tuning coils can be used instead, however. It is advisable to use variable condensers across the coils, as shown in the schematic diagrams, in order to provide close tuning. These condensers are omitted in the photodiagrams in order to avoid confusion.

In the straight radio frequency circuit shown in Fig. 3 on page 64, a radio frequency current flowing in the A circuit is reproduced in the same form, by induction, in circuit B. By proper adjustment of the potentiometer this current is reproduced in the same form but in greater strength in circuit C through the amplifying action of tube 1. If the primary winding of a radio frequency transformer, RT_1, is placed in the plate circuit of the first tube, and the secondary of the transformer is placed in the grid circuit of the next tube, as shown in Fig. 3, the current flowing in circuit C will be reproduced in the grid circuit B_1 of tube 2. This current in turn will be amplified by tube 2 and will result in a stronger current in plate circuit C_1, with characteristics similar to the original current in the A circuit.

By adding extra circuits and tubes the current can be strengthened. The current in the last plate circuit then can be rectified and reduced to audio frequency in either a crystal detector circuit, as shown in the diagram, or in a vacuum tube detector circuit.

Now audio frequency amplification, or the strengthening of audio frequency currents, is accomplished in much the same way as radio frequency amplification. The main difference is that since we are dealing with low frequency currents, the transformers used vary greatly from those used in radio frequency circuits.

In audio frequency amplification the various stages in amplifying the original current proceed in the same way as in radio frequency amplification, with the exception that the F terminals of the secondaries of the transformers connect directly with the minus lead of the A battery instead of being connected indirectly with the A battery leads through the potentiometer, as is the case in the radio frequency stages.

In the straight vacuum tube circuit shown in Fig. 1, the potentiometer is adjusted to the point where rectification or detection takes place. Instead of this, however, an amplified radio frequency current can be made to flow in the plate circuit by proper adjustment of the potentiometer. This is what is done in the reflex circuit shown in Fig. 2. Disregarding the transformer winding shown in the grid circuit of this diagram, we shall trace what happens to an incoming wave.

The current flowing in the A circuit is reproduced in the B circuit and by proper adjustment of the potentiometer is amplified by the tube and produces a radio frequency current in the plate circuit. The primary of a radio frequency transformer is inserted in the plate circuit and the phones and B battery are shunted by a condenser to bypass the radio frequency currents around the phone windings. By connecting a crystal detector in series with the secondary winding of the radio frequency transformer, RT_1, and the primary winding of the audio frequency transformer, AT_1, a rectified low frequency current can be made to flow in the detector circuit.

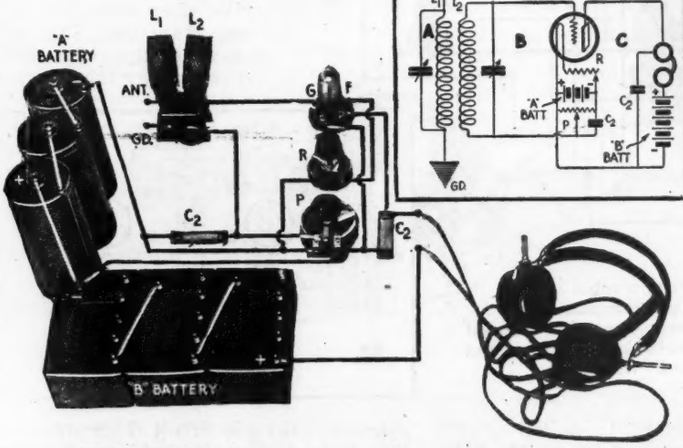
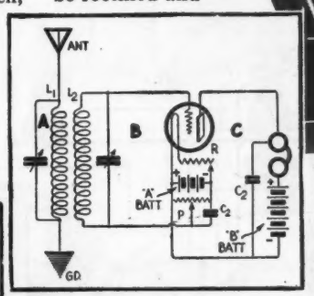


Fig. 1



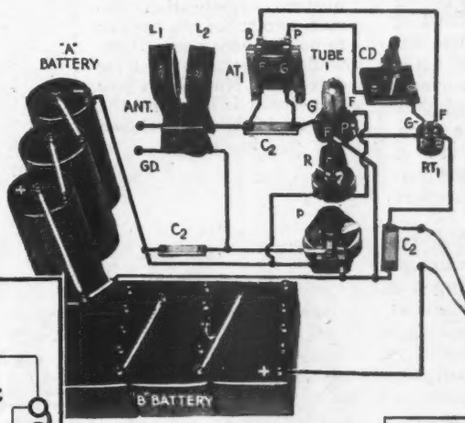
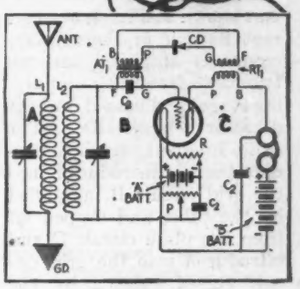


Fig. 2



Transforming Standard Circuit into a Reflex Set

At the left is the fundamental vacuum tube circuit, shown in photo and schematic diagrams. On this circuit are based all the supposedly complicated circuits.

Above is the hook-up for the single tube reflex circuit. Note the close relation between this circuit and the standard tube hook-up, Fig. 1. The standard circuit is transformed into the single tube reflex circuit simply by adding an audio frequency transformer, a crystal detector and a radio frequency transformer, in the positions shown

Explanation of Abbreviations

- L_1—primary coil, 35 to 60 turns.
- L_2—secondary coil, 40 to 60 turns.
- AT_1—first stage audio frequency transformer.
- AT_2—second stage audio frequency transformer.
- RT_1—first stage radio frequency transformer.
- RT_2—second stage radio frequency transformer.
- R—rheostat, 30 ohms for new dry cell tube, 6 ohms for old 6-volt tubes and 1½ volt dry cell tubes.
- P—potentiometer, 200 or 400 ohms.
- A Battery—three 1½ volt cells for new tubes.
- B Battery—22½ to 90 volts.
- C_2—.001 or .002 mfd. condensers.
- CD—crystal detector.
- Ant.—antenna.
- Gd.—ground.

If the secondary of AT_1 now is connected into the grid circuit B and shunted by a fixed condenser C_2, an audio frequency rectified current will flow in the grid circuit. This current will have characteristics similar to the current flowing in the detector circuit. The condenser C_2 shown across the FG terminals of AT_1 offers an easy passageway for the radio frequency current originally flowing in the circuit and prevents it from going through the winding of the transformer. It also provides an open circuit for the audio frequency current. The audio frequency current then is amplified by the tube and actuates the phones. It will be noted that there are two currents flowing in the grid and plate circuits at the same time, but because they are of widely separated frequencies, they do not interfere with each other.

The same method of tapping off from one circuit and introducing the tapped-off current into another circuit, as in the single tube reflex circuit, can be done with a larger number of tubes.

In the two-tube reflex circuit shown in Fig. 4, the current flowing in the primary circuit is amplified through two radio frequency amplifying stages and passed into the detector circuit D. The audio frequency rectified current then is introduced into the grid circuit B, amplified by the tube, and tapped off from the plate circuit C and introduced into the grid circuit B_1 of tube 2 by the transformer AT_2. It is then amplified by tube 2, resulting in a greatly strengthened audio frequency current in plate circuit C_1. This current then will actuate the diaphragms of the phones placed in this circuit.

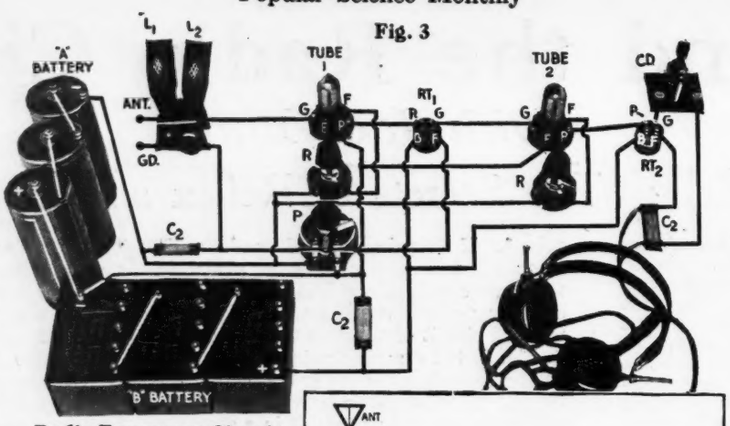
It will be noted that wherever the windings of the audio frequency transformers are introduced into circuits in which radio frequency currents are present (such as between points 1 and 2 in the grid circuit B_1), a fixed condenser C_2 of .001 or .002 mfd. capacity is used to bypass the radio frequency currents flowing in the circuit, thereby preventing them from going through the high resistance windings of the audio frequency transformers. The low or audio frequency currents, however, find an easier pathway through the transformer windings, so that the circuit between points 1 and 2 might just as well be open. The use of these bypass condensers, shown in the diagrams as C_2, is very important.

The inverse duplex circuit merely is a modified form of the reflex circuit, and if you understand the reflex circuit, it should present few difficulties. In the inverse duplex, the output of the detector, instead of being introduced into the grid circuit of the first tube and being amplified progressively in the same order as the radio frequency currents, goes through the amplifying stages in the reverse order. The output of the detector circuit as shown in Fig. 5 is introduced into the grid circuit B_1 of tube 2. The amplified audio frequency current in the plate circuit C_1 of tube 2 then is introduced into the grid circuit B of tube 1, amplified by tube 1 and made to actuate the phones placed in the plate circuit C of tube 1.

The same principle applies when more than two stages are used. In such cases the output of the plate circuit of any tube is introduced into the grid circuit of the preceding tube instead of into the grid circuit of the succeeding tube, as is the case with the straight reflex. In the straight reflex circuit the first tube of the series handles a weak radio frequency current and a weak audio frequency current, while the last tube handles a strong radio frequency and a strong audio frequency current. This arrangement, therefore, has a tendency to underload the first tube and overload the last tube. In the inverse duplex a better balance is obtained, since the first tube will handle a weak radio frequency current and a strong audio frequency current, while the last tube will handle a strong radio frequency current and a weak audio frequency current.

Next month Jack Binns will explain the design of timed radio frequency and neutrodyne circuits.

Fig. 3



Radio Frequency Circuit

In this straight radio frequency amplification circuit, two tubes are used as radio frequency amplifiers, while a crystal is used for detection. Note again how this circuit is based on the standard tube circuit shown in Fig. 1

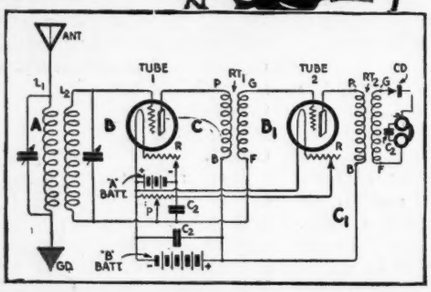
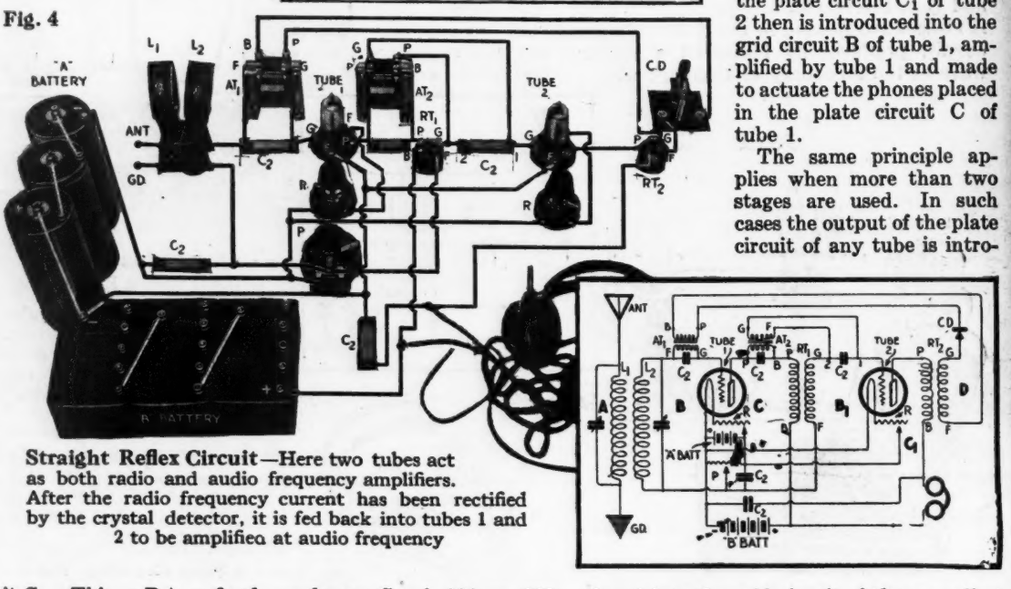
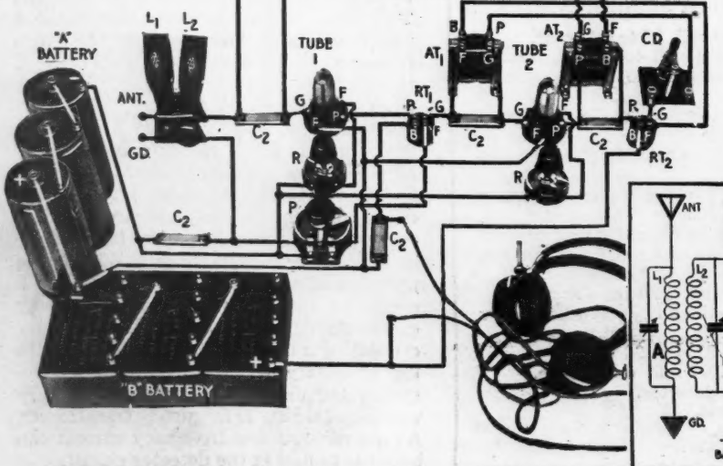


Fig. 4



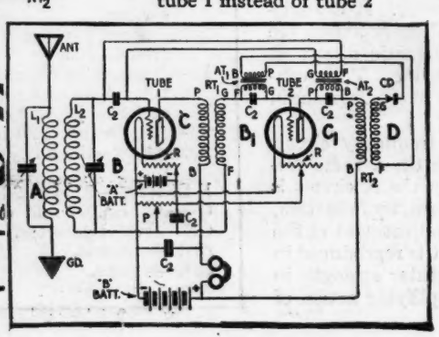
Straight Reflex Circuit—Here two tubes act as both radio and audio frequency amplifiers. After the radio frequency current has been rectified by the crystal detector, it is fed back into tubes 1 and 2 to be amplified at audio frequency

Fig. 5



Inverse Duplex Circuit

Here the operation is the same as that of the reflex circuit, except that the rectified current is amplified first by tube 2, then by tube 1, instead of the opposite order. Also, the telephones are placed in the plate circuit of tube 1 instead of tube 2



Beauty Made to Order by Machine

New Inventions for Household Convenience

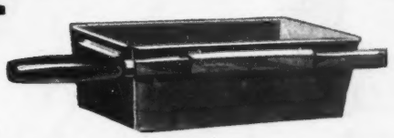
A Page of Useful Ideas for Greater Comfort in the Home

This fork attachment "takes the cake." Slipped over an ordinary table knife, it assists in the well known domestic juggling feat of serving layer cake

A toothpaste cabinet fastened to the wall is the latest in bathroom conveniences. The tube is inserted in the cabinet. A durable tape connected with an outside hand key rolls up the tube as key is turned, ejecting paste

Either a long or a short handle can be inserted in the block of this floor mop. The block serves also as a handle in wringing the mop

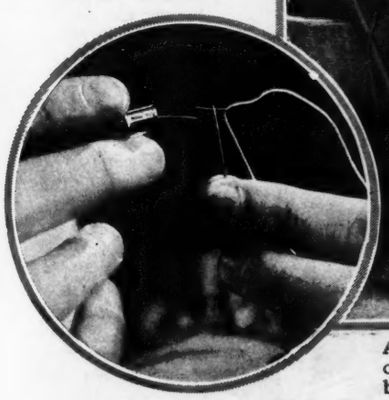
Knife and scissors grinding at home is made easy by the machine shown above. All that is necessary is to place the blade between the two rollers and turn the crank. Even fine silver table knives can be sharpened in this manner without injury

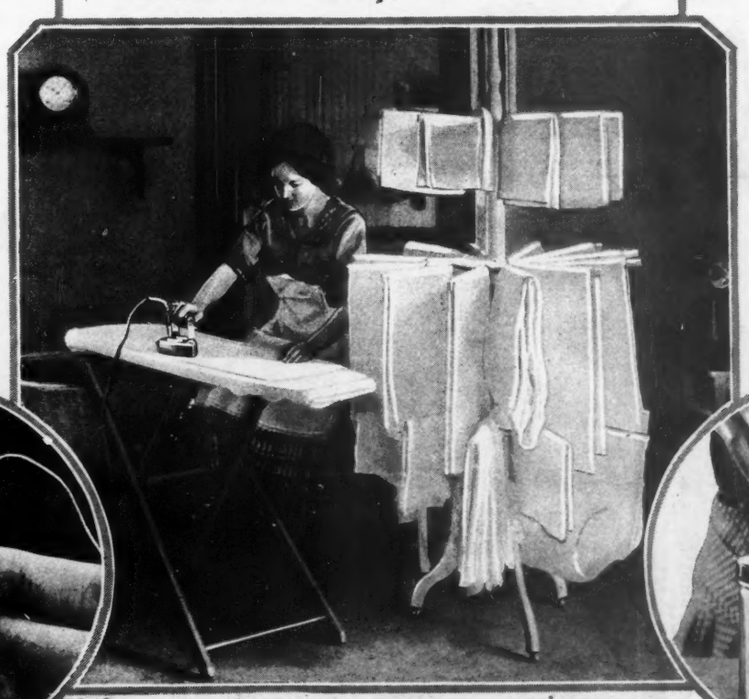


A safety device for handling hot baking tins consists of narrow strips of metal attached to the sides and ends, into which fits a metal bar with wooden handle

This new oven thermometer measures heat just as a clock measures time. The temperatures of either gas, coal or electric ovens are read on a dial. Accompanying the thermometer is a chart showing the correct heat required for baking various articles of food

For persons with poor eyesight, the ingenious needle threader shown below holds a fine wire loop that may be inserted easily through the eye of a needle. The thread is placed in the loop and quickly drawn through the needle's eye





A large family wash may be hung in a small kitchen by use of the triple hanger shown above. Thirty-six arms that may be folded or extended provide 40 feet of hanging space

The onion mincer shown below is designed to save the housewife tears. The onion is dropped into a covered glass jar, where it rests on a small wooden chopping block. Four cutting blades operated by a spring plunger do the mincing

Beauty Made to Order by Machine

MEDUSA?

Curls that stay curled are produced by this electrical permanent waver — an entirely new beauty device. First the hair is wound on curling rods, moistened with a permanent wave lotion, then wound with flannel, until little pipe stems stick out all over the head. These are inserted in hermetically sealed heating tubes, suspended from a chandelier as shown above. After steaming for seven minutes, the hair is unwound and shampooed. And there are the coveted curls

A COAT OF SUNBURN WHILE YOU WAIT

From Paris comes this new appliance. Powerful reflectors bathe the skin and hair with ultra violet rays, said to produce a glorious vacation tan in a few minutes. It is claimed the rays also nourish the hair

CURLS FOR A WEEK

At the right is the latest machine for drying delicately the water waves that make the hair a sea of curling billows for a week. These waves are formed by moistening the hair with water

DUNCE CAP? NO!

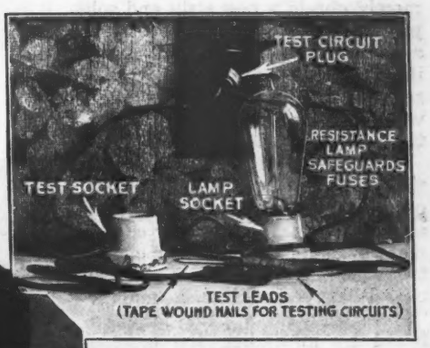
It's a beauty cap—the newest invention for drying the scalp and skin after the hair has been waved. An electric heater and blower circulate warm air through the pipe and into the cap, where it thoroughly dries the scalp of the beauty "patient"

Repair It Yourself

Simple Ways to Mend Worn Electrical Heating Appliances at Home

By Victor H. Todd

Member American Institute of Electrical Engineers

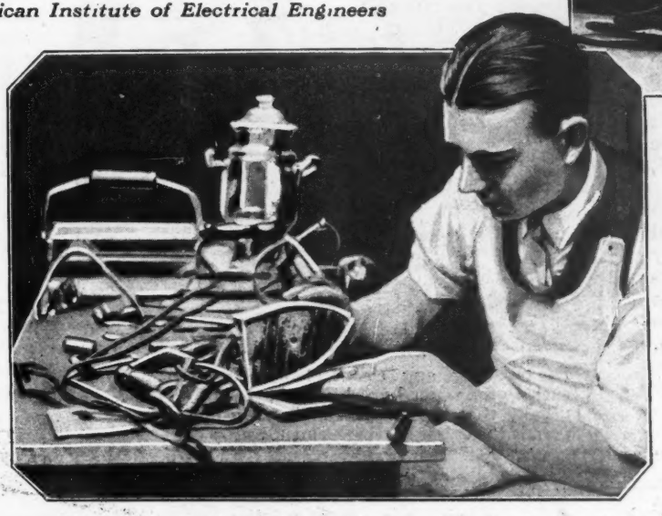


This simply constructed apparatus for testing heating appliances consists of two sockets connected in series from a wall plug. In the socket at the right is inserted an electric lamp. The appliance to be tested is connected with the socket at the left. With each terminal of the test socket is connected a test lead ending in a tape-wound nail. These leads are used to connect terminals of the heating appliance into the circuit

IN ALMOST every household there is at least one piece of electrical apparatus—usually a flatiron, a toaster, or a heater of some sort—that won't work. Either it appears to be "burnt out" or it blows a fuse every time it is connected.

If you have such an appliance, don't throw it away. Try to fix it yourself.

Heating appliances probably are the easiest sort of electrical apparatus to repair, for they contain neither fine wires nor complicated wiring systems. The heat is produced by passing electric current through a winding of wire or a resistance strip. This heating unit usually is held in place by only one or two screws and in consequence may be removed easily and replaced.



Dismantling an electric iron. After two bolts in the handle are removed, the heating element can be inspected readily

Before deciding that the heating element, whether coil or strip, is burnt out, be sure that the trouble is not caused by a defective cord or plug. Flatirons especially are likely to fail to work from this cause, for the wires inside the insulation of the flexible cords connecting them with the sockets frequently are broken by being carelessly kinked and twisted. The methods of finding a defect in a cord were described in my article on fixing household motors last month. Be sure, though, in replacing your cord that you use an asbestos insulated cable, since cords insulated with rubber are likely to cause an offensive odor when heated, and to develop short circuits.

When to Replace Switch and Plug

After you have satisfied yourself that the cord is not defective, look next to the plug and the cut-out switch. These should be dismantled and the contact surfaces carefully cleaned with emery. If the blades or the contact springs are badly discolored, it is likely that heat has destroyed the temper. If so, it is better to replace the switch or plug with a new one. Any attempt to clean and rebend blades and springs that have been softened by heat will result only in a makeshift. They may make good contact for a few weeks, then they are almost certain to produce an open circuit again. If a new plug or switch is installed, the contact surfaces should be cleaned with emery in order to avoid a recurrence of the original trouble.

To test the cord, plug, and switch, rig up the apparatus shown in the illustration at the top of this page. It consists of two sockets—a test socket and a lamp socket—connected in series from the wall plug. Insert a large power lamp in one socket to prevent blowing of the fuse. In the test socket insert the plug of the heating appliance lead. If any short circuit exists either in the plugs or the wires, the lamp will light. If it does not light, wiggle and twist the wires where they are connected with the plugs. If the lamp flickers now, it denotes an imperfect connection that will develop heat and trouble when the heating appliance is in use.

If, after defects in cord and plug have been remedied, the appliance still fails to heat, it probably is burnt out. To determine whether this is so, place a small test lamp in the lamp socket, and to the test socket attach two leads terminating in tape-wound nails. Now touch these leads to the terminals of the heating appliance. If the test lamp lights, the heating circuit is in good condition. If it fails to light, the next step is to open up the appliance and locate the trouble.

If it is an electric iron that is being examined, this step should be comparatively simple. First remove the bolts in the handle of the iron that hold the top and bottom of the appliance together.

The heating element usually is wound with a flat strip of resistance metal on a mica card, placed above the base of the iron.

Iron May Need New Element

Before proceeding further, carefully examine the connection between the strip and the terminals. If this connection is open, it may be reconnected; but if the open circuit is caused by a break in the actual winding, do not attempt to weld or braze the joint; it will only make a bump and cause the strip to burn out. A new element may be bought at a reasonable price and reinserted, making the iron as good as new. If possible, obtain the heating element recommended by the manufacturer of the iron. This may be put in place with a sheet of mica above and below the heater and the iron tightly bolted. Then trim off any rough mica edges that project.

Upon replacing, test the iron for "grounds." To do this, connect one side of the test line with the plug and the other test line with the base of the iron. Use a large lamp in this test, connecting the repaired iron at the test socket. This will cause the iron to become warm if the lamp lights, indicating a short circuit. This must be found and corrected before the iron is put to actual use.

If your coffee percolator is out of order, it may be because you carelessly permitted the current to remain on after the coffee had boiled away. To prevent the heating element from burning out when this occurs, a fusible strip or a quick-break thermostat is placed in the bottom of the tank (usually under a false bottom). When the apparatus is overheated, this strip melts or the automatic switch opens up. If the "open" is due to either of these causes, you need

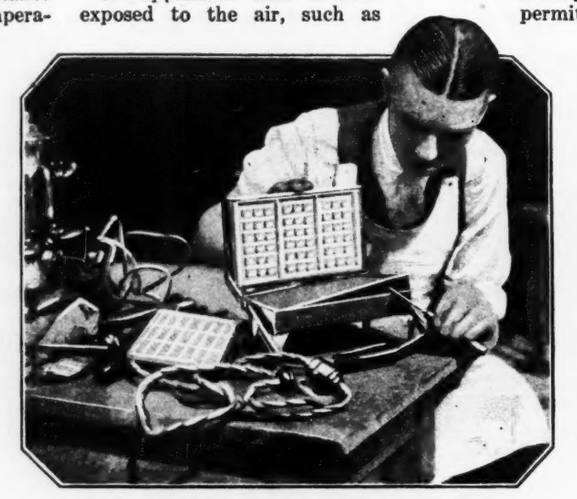
Failure of the electric percolator may be due to the melting of a protective fuse or the opening of a thermostatic switch in the false bottom of the appliance

merely obtain a new strip and solder it in place, or clean and reclose the thermostatic switch by hand. In percolators, the heater, if burned out, may be easily removed and replaced. Never try to solder the resistance wires if broken, as the operating temperature will only melt the solder.

Heating pads should be handled with care as their heating elements consist of very fine wire wound on asbestos rope. With proper care a pad will last many years with one or two cord renewals, but with severe use, it may not last a month. "Opens" in these pads may be found by unwinding the outside wrapping of asbestos until the break is exposed. This wire may be cleaned, twisted together, soldered, and retaped.

But don't be too eager to rip apart and unwind when the pad does not heat, for the trouble may lie in the automatic switch or thermostat in the pad. Remove the outside covering and expose the thermostats (there are usually two). Try them with the test lamp. If an open circuit is found, look for broken leads, and open the thermostat if necessary, carefully cleaning the contacts inside with a fine file or emery cloth. Replace and try again. Carefully anchor the cord by using plenty of strong thread or twine, weaving it in and out through the resistance ropes.

In apparatus with heaters exposed to the air, such as toaster stoves and luminous heaters, the heating element is easily burnt out. Knowing this, manufacturers design the apparatus so that a new element may be inserted readily. The removal of a few screws will permit the damaged element to be taken out and a new one inserted.



In repairing any electrical heating appliance, such as the waffle iron shown above, you will find usually that the removal of a screw or two will permit the entire heating element to slip out easily

So don't let your inoperative electrical apparatus lie on the shelf gathering dust. So many men who have no working knowledge of electricity, allow its "mysteries" to scare them. And yet, taken step by step, such repairing as described in this article is very simple. A little thought and a little labor soon will have apparatus working as well as ever before.

The hints I have given in this and the preceding article should be sufficient to enable any one to repair any of the electric utensils to be found in his house. Possibly, though, I should utter a warning—if your electrical appliances are working satisfactorily, let them alone! Don't tinker with them unless they are actually out of order.

This is the second and concluding article of Mr. Todd's series.

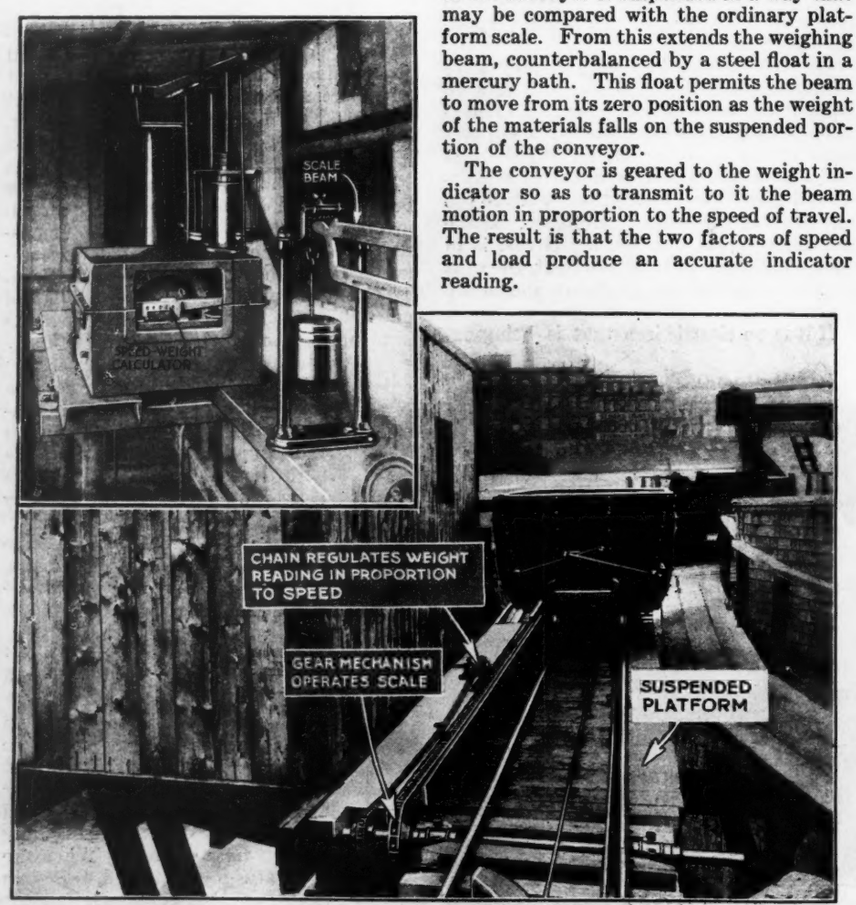
Carloads Weighed while in Motion

INDUSTRIES using large quantities of coal, stone, and similar materials always have lost much time through the necessity of halting the materials in transit to weigh them.

Now there has been devised a scale by means of which any sort of material, whether carried by car, bucket, or on belts, may be weighed in motion. In addition, the scale automatically supplies records both of the weights of individual units and of the total amount of material carried.

This is accomplished by an ingenious system of suspension and gearing. A portion of the conveyor is suspended in a way that may be compared with the ordinary platform scale. From this extends the weighing beam, counterbalanced by a steel float in a mercury bath. This float permits the beam to move from its zero position as the weight of the materials falls on the suspended portion of the conveyor.

The conveyor is geared to the weight indicator so as to transmit to it the beam motion in proportion to the speed of travel. The result is that the two factors of speed and load produce an accurate indicator reading.



Platform of scale that weighs material in motion, showing how portion of track is suspended like an ordinary beam scale. Inset shows beam and weight indicator

Traits of Character Read by Lever Machine

CAN you be depended on in an emergency?

Will you persevere in a difficult task until you have completed it, or will you quit?

Professor Thomas D. Howard, psychologist at Northwestern University, claims that science now can tell these things about you, and can define unerringly other of your characteristics by means of a character-reading machine he has invented.

Traits of character, he asserts, are revealed by the manner in which the person being studied operates a set of signals controlled by hand levers and foot pedals on the machine, in response to dictation of orders from the examiner.

Self-reliant, alert persons will pull the right levers and push the correct pedals unhesitatingly the instant they are informed what signals are desired. Persons of weak and flabby character will fumble around and make mistakes. Egotistical persons will blame their errors on the machine. Persons who lack perseverance will seek to abandon the machine after a few mistakes.

Other differences in personality and character are revealed with equal plainness.

World's Only Bed of Epsom Salts Won by Engineering Skill

By Philip Johnston

Nature's snow-white treasure. Here are lumps of pure Epsom salts found under three inches of soil in deposits near Death Valley, Calif.

THROUGH modern engineering skill the world soon will be able to avail itself of one of its most remarkable chemical deposits—a vast bed of magnesium sulphate, the chemical compound known commercially as Epsom salts.

This deposit—the only one in the world that contains magnesium sulphate in a pure state—is located amid the arid wastes of Wingate Pass, near the west side of Death Valley, California. For years after its discovery it lay untouched, simply because of its inaccessibility to any form of commercial transportation that could be devised. To-day the resourcefulness of engineers at last has succeeded in bringing the desert treasure across rugged mountain ranges and through rocky passes to refineries where it is made available for everyday use.

T. H. Wright, of Los Angeles, uncovered the deposit while prospecting in the valley many years ago. He realized its value, and scientists who examined it confirmed his estimate. But they were helpless to move it. The nearest railroad was more than 70 miles away. Building a connecting railroad line over the mountain ranges which intervened manifestly was impossible. Use even of the hardy mule teams which hauled borax from other parts of the valley was impracticable here, for the roads and trails scarcely could be negotiated by a pack animal.

Monorail Line Offers Solution

The development of the motor truck offered no solution of the difficulty, for, even if it were possible to build automobile roads, the trucks themselves would be unable to withstand the wear and tear of frequent trips to and from the valley.

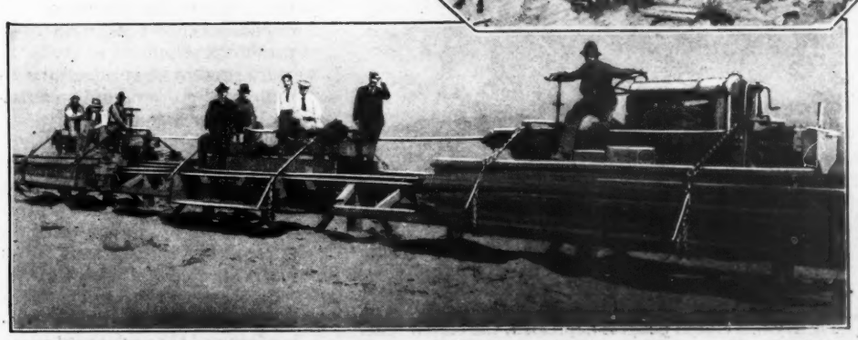
Yet in spite of all obstacles, Wright continued to work on his problem. Recently he perfected a revolutionary type of monorail that promises the only practical solution. Construction of his road has progressed to a point which seems to indicate that Epsom salts from the Wingate Pass deposit will be placed on the market within a few months.

The single rail of Wright's railroad is hung on a trestle. The cars are suspended from the rail, making any gyroscopic balancing device unnecessary. Sway and vibration are eliminated by guide rollers running on horizontal planks on each side of the trestle and three feet below the rail.

The cars are designed to carry five tons each, and it is expected that trains of 20 cars will attain a speed of 12 miles an hour when the road is electrified. At present, the monorail is being used only for construction purposes, power being supplied by a special tractor capable of hauling two five-ton cars up a 10 per cent grade.

In its course from the mine to the railroad at Trona the monorail cars frequently will be required to climb 10 per cent grades and round 40 degree curves—feats that would be impossible with any type of standard or narrow gage railroad. No earthwork is necessary in construction, for the height of the trestle can be varied according to the contour of the ground. The cost of construction is said to be much less than that of a truck road.

The world gets its supply of Epsom salts at present from Germany and the United States. The German product is mined from great depths, and requires three separate processes of crystallization to remove chemical impurities. Filtering then is necessary to take out particles of earth that are mixed with the solution.



Monorail cars hauled by a special tractor used in construction work on the monorail line into the Wingate Pass Epsom salt deposits of California. The upper photograph shows part of the remarkable railway winding in and out among rugged mountains

Methods of Preparation Simplified

The preparation of the usual American product is even more difficult. Magnesite, or magnesium carbonate, a hard rock found in various parts of the country, is first crushed, then treated with sulphuric acid. Magnesium sulphate is formed in the process, but in an impure state, requiring several operations of filtration, crystallization and evaporation to be purified.

Preparation of the salts found in Wingate Pass is extremely simple as compared with methods used elsewhere. The salts are dissolved in water, all dirt and silt settling to the bottom. Then the temperature of the liquid is lowered slightly, causing a small percentage of sodium sulphate to crystallize out, leaving a mother liquid of magnesium sulphate. After filtration, this is 99.8 per cent pure. After the water has been evaporated, the salts are ready for the market. It is estimated that Epsom salts can be refined in this manner for about one fifth the cost of obtaining them from magnesite.

The visitor to the deposit observes only a bit of desert landscape, interspersed with small hills that appear to be composed of clay. But the soil on these hills is only two or three inches deep, and under it lies a hard crust of pure magnesium sulphate, white as snow. The deposit covers 1400 acres. That it has remained intact is due to the absence of rain, which would have washed the salts away.

500,000 Miles in World's Best Equipped Auto

WANDERER III, official scout car of the American Automobile Association and accredited representative of the government National Parks Service, is said to be the best equipped and most dependable car in the world.

This remarkable automobile, fitted with every conceivable appliance and accessory for efficiency and service, has made 16 trips from the Atlantic to the Pacific, and has covered 500,000 miles of highway in the United States during the last seven years. It works as a pathfinder, inspecting automobile routes, finding new trails and locating impassable roads.

An endless tread attachment, running on rollers located beneath the runningboards, enables the car to traverse the roughest country. Other equipment includes:

Powerful jacks, capable of raising the car, which weighs 7400 pounds, five feet from the ground.

Unusually powerful headlights that illuminate the road for 1500 yards.

Special compressed air shock absorbers.

A compass, grade meter, altitude meter, mapmaking instruments and special thermometers that record temperatures inside and outside the machine.

A battery recorder that indicates the charge and the amount of water in the battery.

An apparatus that makes a complete road log of every trip the car completes.

The Wanderer III. Note the elaborate dashboard equipment at the right

Treated with radium, all the registering and recording instruments can be seen almost as clearly at night as in the daytime.

One of the most striking features of the Wanderer III is a new electrical lubricating system. Simply by pressing an electric button the driver can oil the entire chassis while the car is in motion.

New Automatic Gear Shift Controlled at Steering Wheel

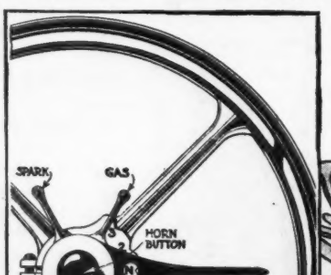
FOR years automobile drivers have wondered why somebody didn't invent an automatic gear shift that would operate mechanically without electricity or some other outside power agency—a gear shift suitable for any car and one cheap enough in price for the average pocketbook.

At last a group of Michigan automobile men claim to have perfected just such a device and have incorporated to manufacture it.

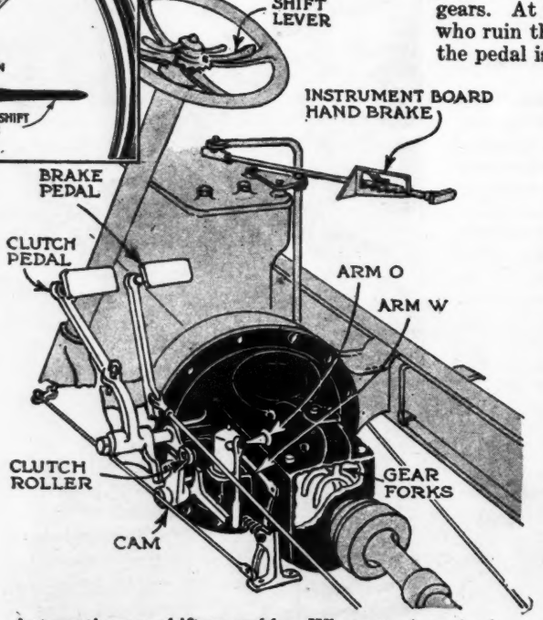
While automatic gear shifts have been in operation on several makes of cars for some time, they have depended for operation chiefly upon electricity. The new apparatus is mechanical and its action is positive, although the personal element so necessary for the proper control of the car is not eliminated. The driver still can feel the movement of the gears and can control the accelerator accordingly.

The usual action of the clutch and the arrangement of gears have not been altered in the new invention. The usual long arm shift lever has been eliminated, and a small lever arm at the center of the steering wheel takes its place. There are several advantages in this arrangement. One of these is the fact that it leaves more room in the front seat and it becomes easier for a driver to get into the seat from either side. Another advantage is that it is not necessary for the driver to release the wheel when shifting gears. He can shift the speed control arm as readily as he moves the throttle. This lessens the possibility of losing control of the car.

On the shift lever sector there are a number of letters indicating the positions of first, second, third and reverse speeds, as well as the neutral position. When the lever is set for any position, a number of arms operate to move a preselector mechanism into the proper position for that speed.



At the left is shown the arrangement of the steering wheel shift lever that replaces the usual long arm lever above the transmission



Automatic gear shift assembly. When steering wheel shift lever is moved, it operates a preselector mechanism, setting arm W in position for desired speed. Then, when clutch pedal is depressed, the clutch roller passes over a cam, operating arms so that arm O moves the gear forks in transmission box into proper engagement. Note plan of hand and pedal brakes

When the clutch is depressed, a cam is moved to operate a second set of arms which causes the previously set shifting arm to engage the gear yokes and move them into the proper position. Upon the release of the clutch pedal the engine again is hooked up with the transmission system and the car is driven through the set of gears selected with the shift lever.

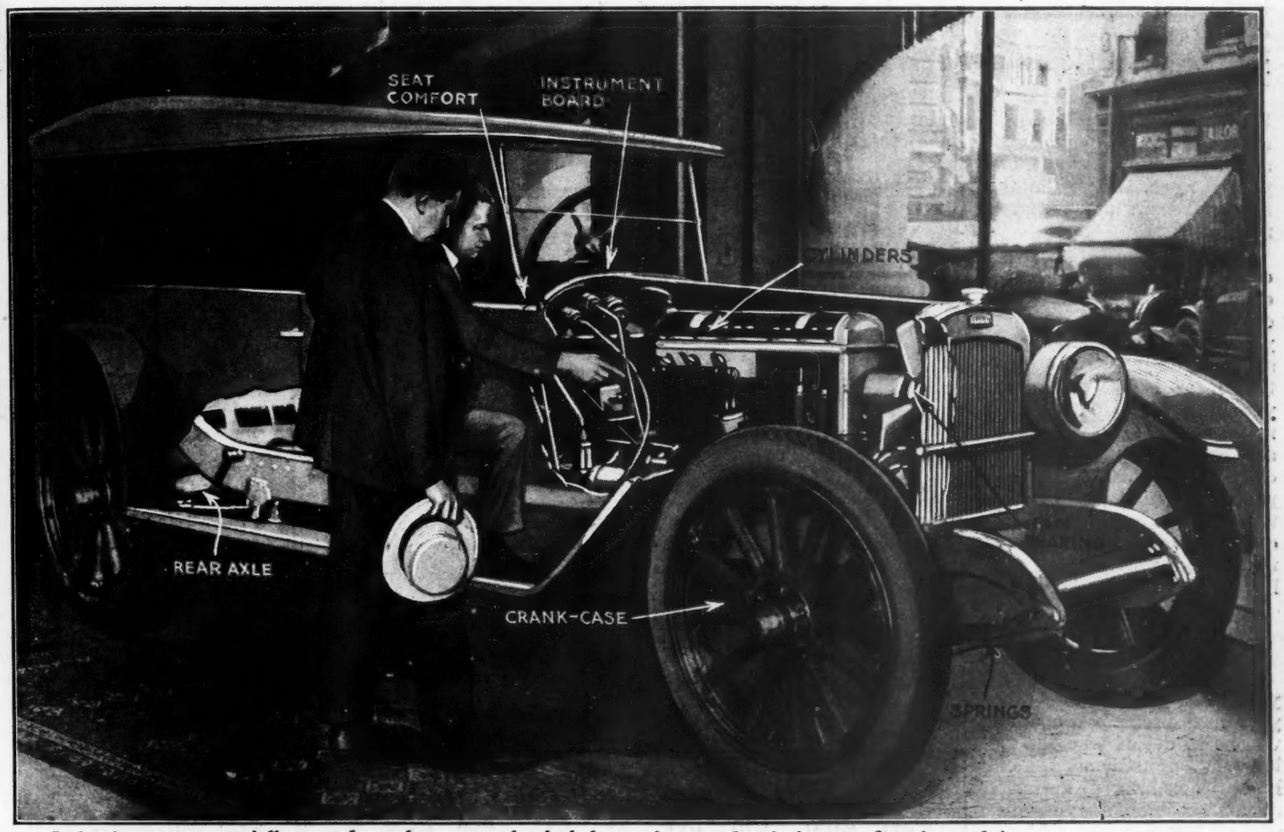
Since the shifting cannot be accomplished before the clutch has been disengaged there is no danger of stripping the gears. At present there are many drivers who ruin the gears by trying to shift when the pedal is not completely down. This is obviated in the automatic gear shift because the design of the shifting cam is such that the device will operate only when the pedal is fully depressed.

Because of this feature, it is possible to change the preselector from high to second speed while going up a hill and having the shifting mechanism in immediate readiness for a change. This eliminates the possibility of stalling the car while changing gears, a frequent occurrence with the present methods.

At present it is necessary to remove all power from an automobile during the period in which the shift lever is moved. With the new arrangement, it is necessary only to throw out the clutch and let it back again. The car will not have slowed up appreciably during that short interval.

In starting the car the lever is placed in first position. Moving forward through the neutral position it is then placed in second speed, and finally in third.

How to Get Your Money's Worth When You Buy a Car



In buying a car, especially a used one, have a mechanic help you inspect the vital parts of engine and running gear for any flaws, as indicated above. Then drive the car yourself to test its performance

By Harold F. Blanchard
Noted Automobile Expert

IF YOU are about to buy your first automobile, you probably are confronted with at least four perplexing questions. How much should you pay for a car? What make is best for you? Should you buy a new or a used car? Should it be a closed or an open model?

Scores of prospective purchasers have asked me these questions. The last three are somewhat difficult to answer; first, because there is not much to choose between various makes of cars at any particular price in this day of standardization. Then the question of whether the car shall be a new or a used one can be decided only after careful consideration of the values offered. And, finally, the question of an open or a closed model depends largely upon individual tastes and needs.

But the first item can be answered with scientific exactness. The price that should be paid has been figured out closely by economists and statisticians. They agree that you can afford a $500 car on an income of $2000, and that it is not advisable to purchase a $5000 car unless your income is $20,000 or more. A careful analysis of these figures shows that you can afford to spend a sum equal to 25 per cent of your annual income—not every year—but one year in five. Thus, if you receive $5000, you can afford to buy a $1250 car; if $8000, a $2000 car; if $10,000, a $2500 car; if $15,000, a $3750 car.

By purchasing a car which lists at 25 per cent of your income for one year, you bring the total expense of upkeep well within your means. If you are earning $2000, the yearly cost of running a car, assuming you give it the average care, will be $276.60 or 13.38 per cent of your income; if you receive $5000 annually, and buy a car according to your means, your total running expense will amount to $473.20; while if your business pays you $20,000, the total car upkeep cost will figure $1488 or 7.44 per cent of your income.

On a mileage basis the cost of running your car, all expenses considered, will vary, according to the initial cost, between 4.46 cents and 24.80 cents, as tabulated on page 72.

The figures in this table are designed to represent an average case in each particular class. The initial cost of the car includes war tax, freight, and all extras. Also it is assumed that the car is driven 30,000 miles over a period of five years, and that at the end of that period it has a value of from $100 to $600, depending on its original price. The cost of gasoline is figured at 25 cents a gallon, while the mileage a gallon varies from 22 miles for the $500 car to 10 miles for the $5000 car. Some cars may exceed these figures; others may fail to reach them. But it may be assumed that they strike a fair average.

There always will be some question about oil consumption. Some owners obtain 300 miles or more per quart and others get less than 50 miles; it depends on the condition of the engine and the construction of the lubricating system. Averaging up these factors it has been found that 100 miles per quart of oil for cars valued at less than $2000, and 150 miles for cars above $2000 is a fairly accurate estimate.

Oil and gas are the first things the average motorist thinks of in computing his operating costs, but there are other expenses that must not be overlooked. Tire cost is an important one. Since cord tires now are used largely, the average car may be expected to run approximately 12,000 miles on a set. Consequently tires must be purchased at about the 12,000 mile mark and again at 24,000 miles. This means at least eight tires with tubes and flaps, in the five year period—tires costing from $22 to $48, according to the class of car.

Then there are the items of

DID you know that failure to keep the steering knuckle of your car properly oiled may result in fatal accident? In an important article next month will be revealed scientific secrets of automobile lubrication, learned by experts through long experience—facts that not only will help you to cut down car costs, but may save you from possible injury or even death. You can't afford to miss this article.

painting, upholstery, top repairs and replacements.

The insurance figures also represent average requirements. If you own a $500 car you are likely to be satisfied with fire and theft protection. But the greater your possessions, the more you are likely to feel the need of safeguarding yourself against damage suits. And that explains why the figures under this head vary from $20 yearly to $200 yearly.

Total repair figures range from $172 to $410 and include valve grinding and carbon removal every 5000 miles, bearing and other adjustments, one set of new piston rings, brake lining, battery repairs and replacements.

Now in purchasing a new car on a scientifically economic basis, the fact to be kept constantly in mind is that your yearly expense figure should not greatly exceed that listed in the table. If your income is $2000 you may spend $276.60 yearly for all items of expense. Depreciation on a $500 car over a period of five years is $400, that is, $100 is the estimated efficiency value at the end of this period, provided the car has been carefully used.

What You Can Afford to Pay for a Car

IN THE first column of the table below, pick out the figure representing your yearly income. Opposite this figure you will read what you reasonably can afford to pay for a car and what it should cost you for upkeep annually. This table is based on scientific cost averages compiled by expert economists and statisticians, and assumes that the purchased car is driven 30,000 miles over a period of five years.

Yearly Income	Initial Cost of Car	Total Yearly Cost of Upkeep	Percentage of Income Spent for Car Upkeep	Total Cost per Mile (in Cents)
$2000	$500	$276.60	13.38	04.46
3500	875	368.60	9.83	06.14
5000	1250	473.20	9.46	07.89
8000	2000	662.40	8.27	11.04
10,000	2500	790.10	7.90	13.19
15,000	3750	903.80	6.03	18.40
20,000	5000	1488.00	7.44	24.80

What It Should Cost You to Run a Car

The table above is based on the following cost figures over a five-year period.

Initial Cost of Car	Value at 30,000 Miles	Insurance Yearly	Oil Mileage Per Gallon	Gasoline Mileage Per Gallon	Cost of One Tire with Tube	Painting Once	Repairs Total	License Yearly
$500	$100	$20	100	22	$22	$50	$172	$5
875	125	30	100	20	26	60	190	7
1250	150	40	100	18	30	70	205	12
2000	300	75	150	16	30	80	245	15
2500	400	100	150	14	40	100	270	16
3750	500	150	150	12	40	125	325	17
5000	600	200	150	10	48	150	410	20

Advice to Buyers

After deciding how much you are to pay for your car, your next problem probably will be to decide whether to buy a new or used one. If you know absolutely nothing about automobiles, you do well to buy a new machine. Then follow the instruction book implicitly in taking care of it. By this procedure you are likely to operate with the minimum expense per mile. To a lesser extent the same holds true of cars a year old, and of some cars two years old.

But as a general rule, used cars more than a year old should not be purchased by inexperienced motorists, because such cars are likely to develop many little troubles. These may not bother the man who is "motor wise," but they are sure to cause much trouble and expense to the novice.

Then, too, used cars three, four, five or more years old are not always bargains. A cheap car more than five years old is likely to cost more to repair than it is worth. For example, a man I know recently bought a 1918 six for $100. He spent $300 trying to fix it up and eventually sold it for just $100. Another man paid $300 for a better car, spent $600 in repairing it, and now, after investing $900, he has a five-year-old machine in fairly good condition. But think of the fine one-year-old cars $900 will buy, or the fine new cars, for that matter!

Figure Cost on "Fixed Up" Basis

In deciding to purchase a used car, ask yourself "Is this car for $300 as good a buy as some other? It will cost $200 to fix it up. Now $200 plus $300 is $500. Isn't there a newer car that I would prefer for $500?" Probably there is.

When determining whether an old car is a bargain, always figure its cost on a "fixed up" basis and never on an "as is" basis. Don't be fooled on the tires. If you figure you will have to buy a complete new set of tires within 2000 miles, probably you will not be far wrong. Then be sure there are no big defects such as cracks in cylinders, crankcase, or rear axle housing. Get a repairman to determine these points if you cannot trust your own eyes. If possible, remove the cover plate from transmission and rear axle and inspect the condition of these parts. Examine the car to determine whether it has been in a collision or a fire. Evidences of straightened members will indicate the former, and charred wood in the body framework often will indicate the latter. If the body structure is sound, fire is not serious, but a collision jars the whole mechanism, throwing the car out of alinement. A car that has been in a collision and repaired, should be purchased only after the most searching examination of its details.

Before you buy, you should drive the car you intend to purchase. Its performance should be carefully noted, and any defects run down to their source. The starter should be used long enough to determine that there are no broken teeth on the flywheel and all gears, including reverse, should be tried, as well as both brakes.

The most common form of deception in selling used cars is to misrepresent the age. Then too, badly worn cylinders sometimes are concealed temporarily by filling the engine with heavy steam cylinder oil, or even by packing the pistons with grease. The easiest way to determine the condition of the cylinders is to have the crankcase drained just before the demonstration and then filled with medium oil—at your expense if necessary.

A great many people are undecided whether to buy open or closed cars. The closed car is becoming the more popular in America. It is considered by many the ideal all weather model, as satisfactory in summer as an open car and much more so in winter. They point out that "the top is always up" and there are no side curtains to bother with in case of sudden storm.

One reason why more motorists do not have closed cars is because of the additional initial expense. Fortunately, within the past year and a half, great strides have been made in the economical construction of closed bodies, with the result that there are several closed cars selling for within $100 of the corresponding open models. Thus the greatest drawback to owning a closed car is being eliminated. But the increasing popularity of the closed car does not mean the passing of open models. These will always have their supporters.

Having determined the price you can pay for a car and whether it will be an open or a closed model, the selection of the particular make remains.

The standard cars built to-day, even more than those built two years ago, generally are satisfactory, so that the selection of a machine in any given price class may be determined by considering comfort, economy and performance. These three classifications should range in importance according to your personal preference.

Trying Out a Car

If you live among steep hills, you are likely to want a good hill climber, or if you live on the plains you may prefer a car with ability to slide along easily at high speed. Take your demonstration on the roads on which you expect to travel.

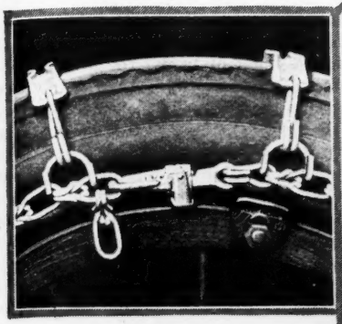
The springs of the car that you favor may work very well on relatively smooth roads but very disappointingly on rough roads. Also take your demonstration at your usual driving speeds, and with your usual quota of passengers. The riding of the car, as well as its ability to climb hills, is directly affected by the number of passengers.

Be especially careful that the driver's compartment is comfortable for you. See that the brakes are powerful and easy acting; that the clutch pedal and gearshift lever suit you; that the accelerator pedal is rightly placed; that the steering gear is correctly positioned and that the seat and back cushions are the right size and shape for your comfort.

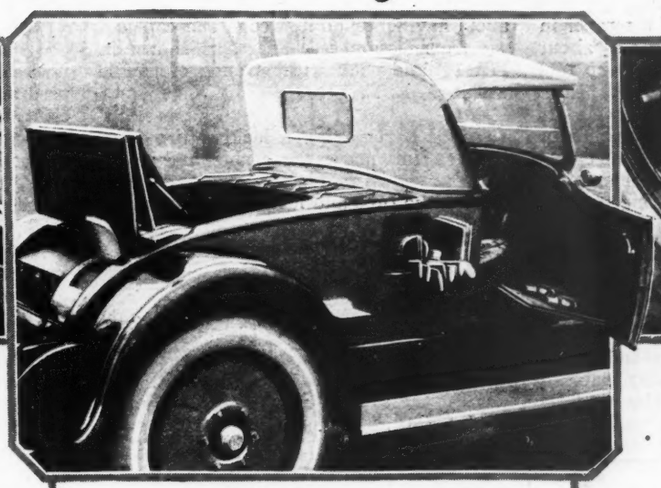
Buy from Reputable Dealer

Finally, other things being equal, you should buy your car from a dealer with a reputation for good service, because if you expect to sell your car after a year or so, the second hand value will be determined largely by the care and service it gets. Some cars have a used value much higher than the average. It depends on how the car has been used as well as on the popularity of the machine. The popularity of a machine in any given price class is an accurate gage of its worth, because popularity is based fundamentally on worth.

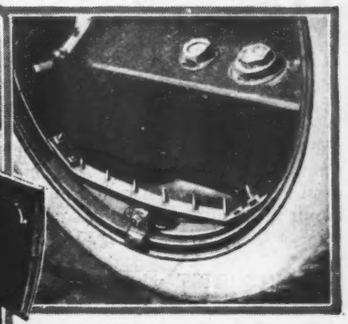
Aids to Car Safety and Comfort



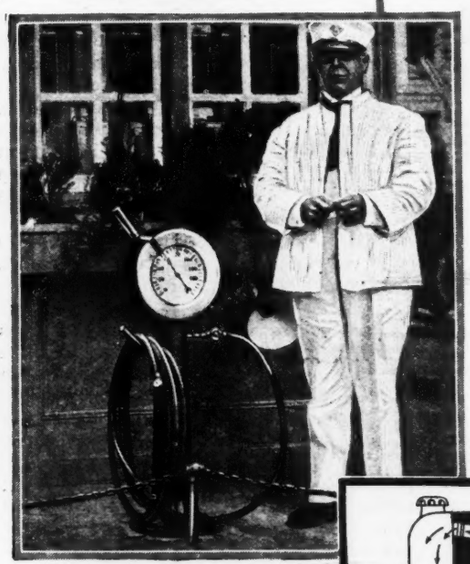
Non-skid cleats of drop-forged steel, somewhat resembling the "spikes" of baseball shoes and locked over the tread of the tire by non-rusting chains, form the latest innovation in automobile tire chains. The special adjustable locking device is shown above



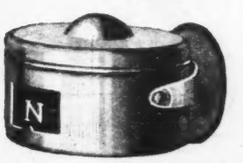
A special locker for the golf bag is just one of many conveniences built into the body of this new sporting roadster. These include a buffet concealed in one door, and an ice chest



To prevent small boys from stealing rides by sitting on the rim of the spare tire, this spiked plate has been devised. When bolted to the tire rack, it offers a seat about as inviting as a picket fence

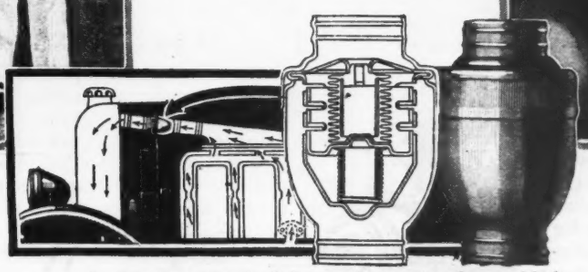


Protection from over-inflated tires is offered by this new control device for service stations. The dial gage is set at the desired pressure. When this is reached, the device automatically cuts off the air

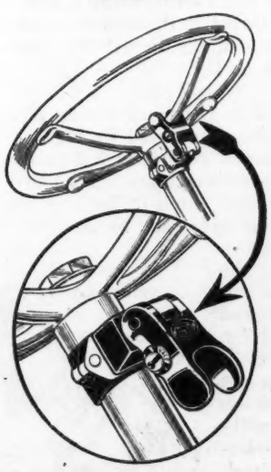


Attached to the windshield, this automobile compass is insulated from the magnetic influence of the metal and electrical apparatus of the car. Possibility of error is prevented further by an inner compensating mechanism

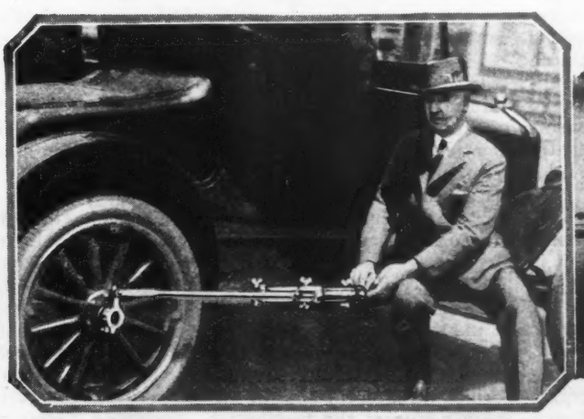
To permit the driver of a closed car to signal in stormy weather, this special window is made in two sections. The bottom section is hinged to open outward as the driver thrusts his arm out



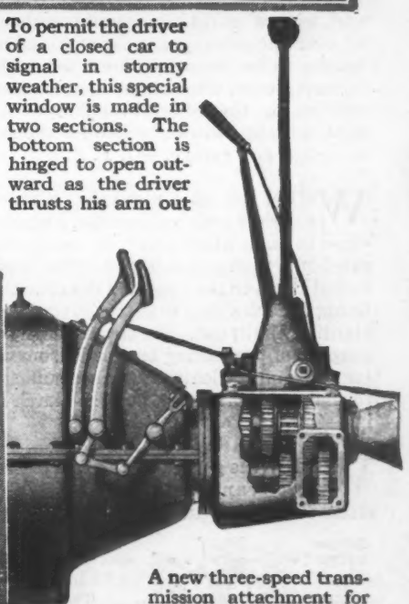
Automatic control of the cooling system is provided by this thermostat, shown in cross section, which is clamped into the hose at the point indicated by the heavy arrow



A new automobile lock fastened to the steering post consists of a steel fork that swings upward on a hinge to engage a spoke of the steering wheel



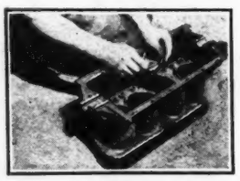
This novel air pump, clamped to the runningboard, is driven by the automobile engine through an arm attached to one of the rear wheels



A new three-speed transmission attachment for Ford cars, resembling the transmission in large standard cars, is said to increase gasoline mileage by eliminating the wearing drag of transmission bands

Hints on Repairing Your Auto

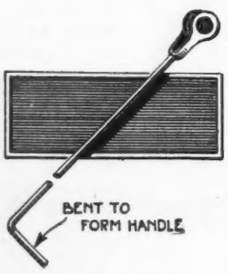
WHENEVER you need a scraper in connection with repairs about your car and have no sharp tool at hand, you will find a discarded piston ring will usually do the work very well. It makes an excellent tool for scraping a bearing and for cleaning carbon from cylinder walls and is an aid in finishing many jobs quickly and accurately. The ring may be used whole or broken in half. Use both hands in handling it and cut with either edge of the ring, as in Fig. 1.—J. W. R.



1. A ring scraper

2. Handy washer

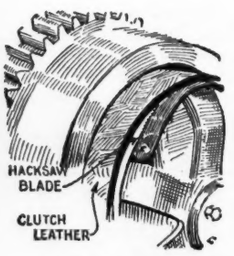
A MOTORIST who did not feel inclined to dismantle certain parts of his car to insert spacing washers in order to take out the rattling play, particularly at the spring shackles and steering knuckle, found that washers made up of pieces such as the one shown in Fig. 2 served satisfactorily. He cut a number of pieces of sheet metal of this shape, inserted them between the parts from opposite sides, and bent over the ends to lock them into proper place. —R. H. KASPER.



3. Petcock handle

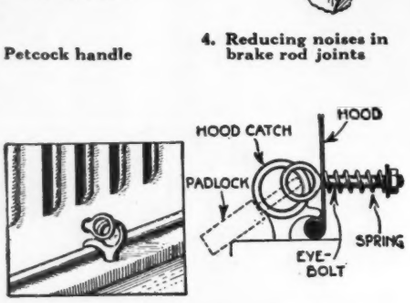
4. Reducing noises in brake rod joints

5. Locating leaks

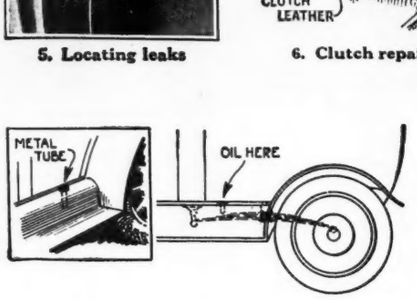


6. Clutch repair

TO TEST the oil level on a Ford without the usual difficulty of opening the petcock by hand, make the tool illustrated at Fig. 3, from a section of discarded brake rod about 2 ft. long. Simply bend one end at an angle to serve as a handle. The regular clevis at the other end, when slightly hammered together, will fit over the petcock handle and enable the handle to be turned without the ordinary inconvenience, then there is no excuse for not testing the oil level regularly. A discarded brake rod can be had for the asking at almost any garage.—G. F. S.



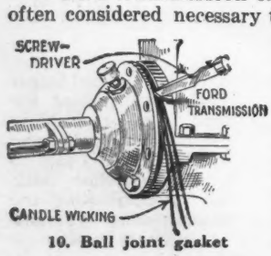
7. Simple method for locking hood



8. Oiling awkward springs

WHEN too much play exists in the cone clutch of your automobile, a repair can often be made quite simply by using a hacksaw blade as shown in Fig. 6. The blade is forced between the cone and the cone clutch lining in such a way that the leather is substantially built out. The saw teeth serve the purpose of preventing the blade from working out, and the leather is raised sufficiently to make a tight seat when the clutch is let in.—C. M.

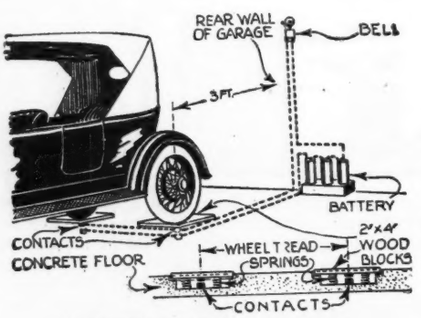
WHEN the gasket on the ball joint of a Ford transmission case is torn, it is often considered necessary to take out the rear end in order to renew the gasket. This is a time-consuming job and one the average car owner dislikes to undertake. To avoid having to do it, wedge the cap and the transmission case apart, as shown in Fig. 10, and pack with strands of candle wicking.—L. Y.



10. Ball joint gasket

BEFORE removing a leaking tire from the rim, mark the casing and valve stem, as shown in Fig. 5. Then, after removing the tube and locating the leak, lay the tube on the casing with the marked side of the valve on top and coinciding with the mark on the casing. This makes it an easy matter to find what caused the leak without searching over the whole tire. Much time is saved, especially when some relatively small puncture has caused the damage. Use chalk or pencil for marking.—G. W. G.

MANY thefts of engine parts in Washington, D. C., have led some car owners to lock their hoods. One method is shown in Fig. 7. The lock is an ordinary forged eyebolt inserted through a hole drilled through the edge of the engine hood at one side of the hood catch. A spring between the hood and nut takes up the play and prevents rattling. To lock the hood the eye is pulled out and a small padlock snapped in its place.—G. L.



9. Electric alarm for backing car

THE use of bolts and lock washers will often overcome annoying brake rod noises. The usual loosely fitting clevis pins used at the ends of brake rods have sufficient shake to cause a certain amount of unnecessary noise and wear. One owner overcomes this by substituting machine bolts, nuts and lock washers, as shown in Fig. 4, in place of the clevis pins and split cotters. When the bolts are perceptibly worn, and there is any indication of noise, they are renewed.—H. A. L.

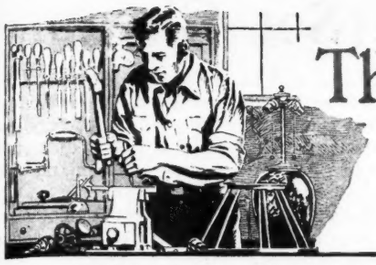
THE electric alarm illustrated in Fig. 9 is a useful device to prevent backing an automobile into the rear of a garage. The contacts are placed in two recesses prepared when the concrete floor is laid, or chipped out afterwards. These recesses are bridged by 2 by 4 in. wooden blocks. The weight of the backing car closes an electric bell circuit and the car is then run back just enough more to release the spring contacts and stop the bell ringing.—C.F.G.

A MARYLAND motorist was forced into a ditch by a collision in which the left front wheel of his car was struck a glancing blow by a car approaching at an angle. He has now moved his double bar type bumper at the front 6 in. off center toward the left, so that it will fend off a car that otherwise might strike the wheel. This arrangement makes improbable any repetition of the accident.—M. F.

WHEN a tube has a small puncture, a quick way to remove any air that will not easily leak out, is to procure a quill, cut a sharp point on it, make a hole in its shaft, and thrust it through the puncture hole. The remaining air will then leak out readily.—R. C. U.

FOR greasing the front wheels of a car the device illustrated in Fig. 11 is a great time saver, especially if a number of cars of the same make are being cared for. A standard hub cap is drilled and a small pipe bushing soldered to it. A pipe nipple or connection to fit the shop grease gun is then screwed into the bushing. With this it is possible to grease the front wheels of the car without disassembling the wheel, for it simply screws in place of the regular cap. —L. R. B.

11. Greasing hubs



The Home Workshop

Arthur Wakeling, Editor

Easily Built Crib and Play Pen

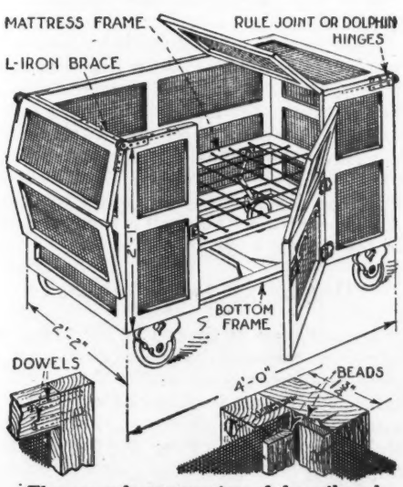
IN EVERY home where there is a small baby, a combination crib and play pen is one of the most necessary and useful pieces of furniture. It can readily be moved from room to room, away from a drafty window, out on the porch, into the yard, on the roof of an apartment house, or wherever needed.

If it has an adjustable mattress frame, like the one illustrated at the right, it can be used with equal convenience in place of a regular high bassinet at night and as a screened-in play yard for the baby's wakeful hours.

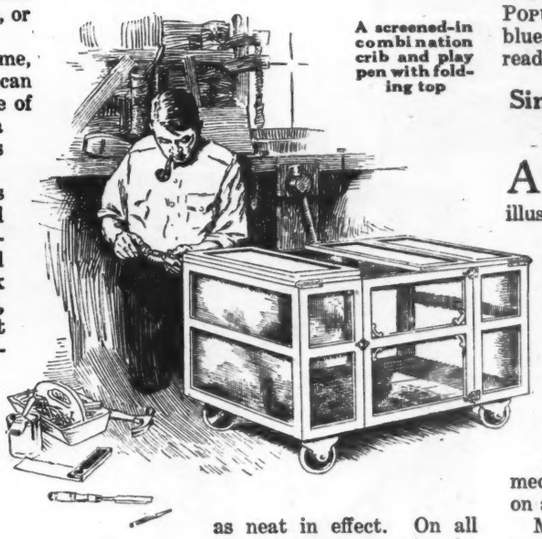
In construction the crib shown is little more than a series of quickly and easily made frames covered with galvanized steel wire cloth, such as is used for fly screens. The ⅞ by 1¾ in. stock for the frames may be of cypress, pine, whitewood, spruce, or any other soft wood. All the joints are doweled together. The largest frame, which is the one for the back, is 2 ft. 1 in. by 4 ft. in size; the front consists of two 12 in. by 2 ft. 1 in. frames, and a third 2 ft. by 2 ft. 1 in. frame makes the door. A variation of this arrangement, shown directly below, is a door made in two parts, hinged together, the lower section being hinged to one of the side frames. This design is convenient whenever the crib is to stand alongside an adult's bed at night, because the upper door can be partly, if not wholly, opened without pushing the crib away from the large bed.

The end frames are 2 ft. ¼ in. by 2 ft. 1 in. Their vertical members are ⅞ in. square instead of ⅞ by 1¾ in. The folding top consists of four frames, each 12 in. by 2 ft. 2 in. in size.

A 2 by 15 ft. piece of galvanized wire cloth is required for covering. It is tacked on the inside of all the frames except the top ones where it is tacked on the outside. It goes in a shallow rabbet in the top frames, and the edges are covered with a thin strip of beading set flush. The rabbets can be omitted and the wire and beads planted directly on the top, but this is not nearly as neat in effect. On all frames except those for the top the edges of the wire are covered with small beads, as shown below at the left.



The general construction of the crib and details of the corners and frame joints

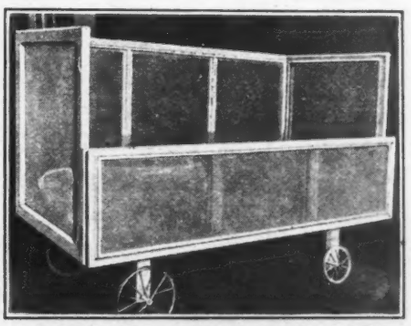


A screened-in combination crib and play pen with folding top

The two center frames of the top are hinged to the outer frames with ordinary butt hinges, but special hinges have to be used for hinging the outer frames to the body of the crib. Commercial dolphin hinges, such as are shown, or homemade rule joint hinges may be used. Double-acting screen hinges 1¾ by 1¾ in. are particularly good for this purpose.

The bottom frame, of 2 ft. ¼ in. by 3 ft. 10¼ in., may also be covered with netting. The mattress frame is a trifle smaller and is corded, as indicated, or covered with duck. It is attached to the lower frame with 14-in. brass rule joint stay or support hinges, which can be purchased at any large hardware store.

The ornamental wheel brackets are cut from hardwood and are doweled to the lower frame. Regular bassinet wheels of solid wood, pressed steel, or wire, with heavy rubber tires are used, as preferred.



A very light spruce play pen, the details of which appear above at the right

The crib is finished with one enamel undercoat and two or three thin coats of white or cream enamel.

Complete details of this unusually fine crib are contained in Blueprint No. 26 of POPULAR SCIENCE MONTHLY'S series of blueprints, which will be sent to any reader at a nominal charge of 25 cents.

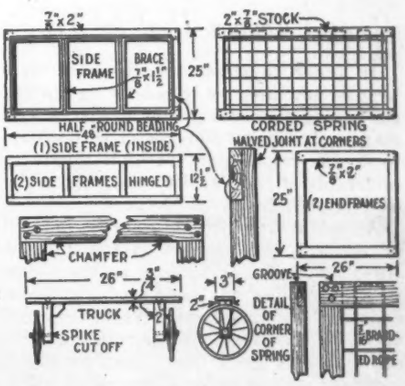
Simple Play Pen Requires Only Six Light Frames

A SIMPLE play pen can be made with only six frames. How this is done is illustrated in the photograph and details below, which show one designed and built by Mr. E. E. Scott, of Pittsfield, Mass.

This play pen is 48 in. long, 26 in. wide, and 25 in. high above the wheels, which are doll carriage wheels with "oversize" tires. The ends and sides are constructed like ordinary window screens except that an end-lap joint is used for the sake of strength. The sides are further reinforced with intermediate braces, as shown. Spruce is used on account of its lightness.

Make up the frames, chamfer the edges to improve the appearance, and tack on ordinary wire fly screen. Half round beading, obtainable at almost any lumber yard or sash-and-door mill, should be nailed over the edges of the wire. The sections should then be joined with three wood screws in each joint except the lower half of the hinged section, which may be held with two screws at each end. The upper half is hinged to it with three hinges and suitable hooks are provided at the top.

Construct a pair of trucks of maple or other hard wood, as shown, and attach them to the bottom frame with heavy wood screws 3 in. long. It will not be necessary to use axles the full width of the bed; they can, indeed, be large spikes driven into holes bored through the wheel supports to a diameter 1/32 in. less than the size of the spike, or heavy wood screws can be used.



Details of frame, trucks and corded springs for play pen shown below at left

How to Build a Supersensitive Set Cheaply

By Joseph Calcaterra
Of Popular Science Monthly's Radio Staff

LOUDER signals, greater sensitivity, more selectivity, more compact sets —these are the rallying cries of radio experimenters.

Each new set has thousands of adherents. Some radio fans pin their hopes on the old reliable single circuit regenerative receiver; others boast triumphs achieved with single tube super-regenerative receivers. Many experts stand by the triple circuit regenerative set, while others extol the virtues of the Reinartz, the Cockaday, the neutrodyne, the Flewelling, and the other more recent circuits.

The average radio enthusiast undoubtedly would like to try them all and then make a selection, but cost, and lack of time and technical skill prevent. To lend a helping hand to Home Workshop readers in just this situation, POPULAR SCIENCE MONTHLY has established an experimental workshop in which receiving sets of various types are being built and tested. From month to month I shall give complete information regarding the construction and operation of these sets, together with all possible information regarding their advantages and disadvantages.

As the first of this series I have chosen the Flewelling circuit, since for the sum expended and the ease with which it can be constructed, it is easily one of the foremost of the supersensitive receivers.

The Flewelling circuit, as Jack Binns explained in POPULAR SCIENCE MONTHLY last month, may be looked upon as akin to the Armstrong super-regenerative hookup.

As far as the actual arrangement of the parts of the circuit is concerned, there is very little difference between the Flewelling and the single circuit regenerative receiver. The only extras are a bank of fixed condensers and a variable resistance of the same type ordinarily used as variable grid leak resistances. With the exception of the slight change in the wiring introduced by this additional apparatus, the circuit is exactly that of the single circuit regenerative receiver.

Unique Coupler Used for Tuning

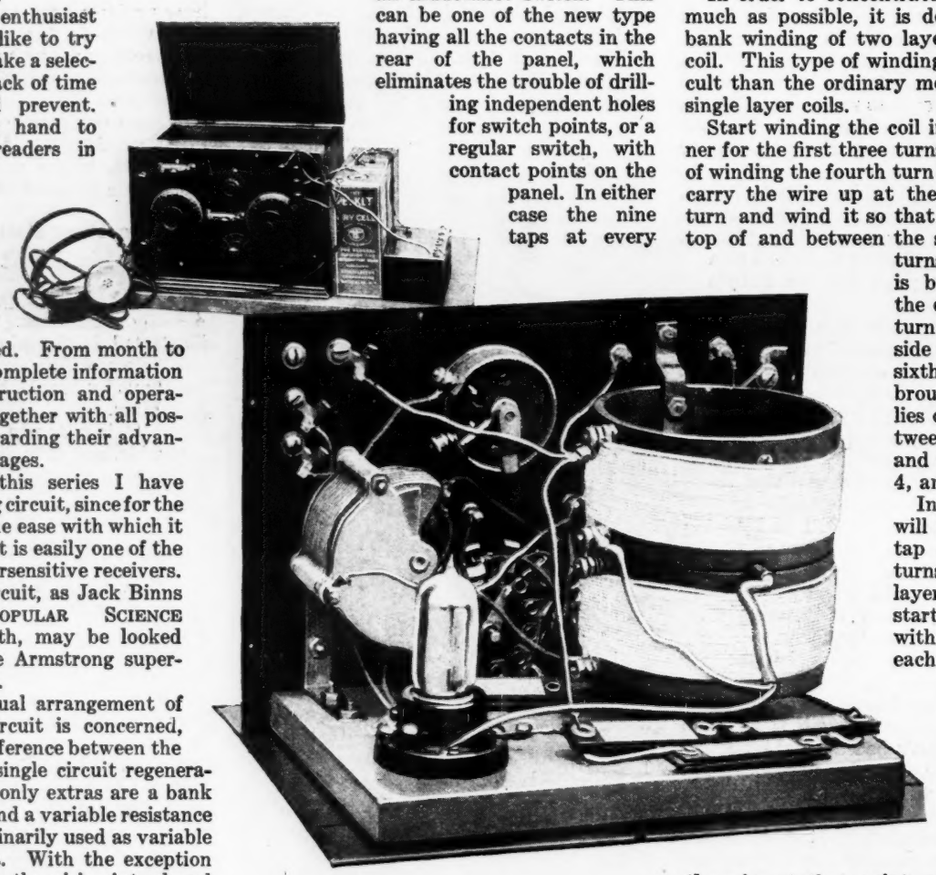
In order to cover the range of wavelengths now used by broadcasting stations, the tuning elements should consist of a primary coil of about 50 turns of wire shunted by a 23- or 43-plate variable condenser, preferably of the Vernier type, and a tickler coil of from 75 to 90 turns.

As it is not possible, ordinarily, to obtain or make a variocoupler having 75 to 90 turns on the rotor for use as the tickler, most Flewelling sets have used honeycomb coils as the inductances. While these coils serve the purpose, they are rather cumbersome to use, since they must usually be mounted on the front of the panel. They also have a disadvantage in distance work caused by the capacity of the hand in making adjustments. This is more pronounced than when a tuning coil of the variocoupler type, mounted in back of the panel, is used.

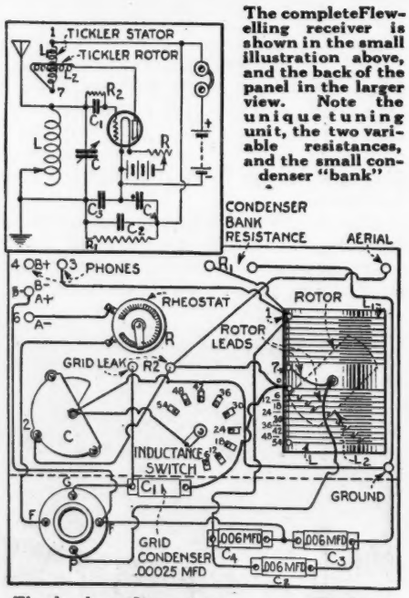
The special type of variocoupler used in the set illustrated can easily be made. The stator is made in two sections, each section being wound independently with 54 turns.

The lower coil, which is tapped, is shunted by the variable condenser, and used as the tuning coil, while the upper coil is connected in series with the rotor winding to form the tickler.

The first tap is taken at the sixth turn of the lower coil and a tap is then taken at every six turns thereafter, making nine in all. The taps are led to the tap contacts of an inductance switch. This can be one of the new type having all the contacts in the rear of the panel, which eliminates the trouble of drilling independent holes for switch points, or a regular switch, with contact points on the panel. In either case the nine taps at every six turns will be sufficient, since the condenser will easily provide the finer tuning.



The completeFlewelling receiver is shown in the small illustration above, and the back of the panel in the larger view. Note the unique tuning unit, the two variable resistances, and the small condenser "bank"



The hookup shown in two ways. The lower diagram corresponds in arrangement to the wiring of the set itself

The size of the tube used is not very important and may be 3½ to 4 in. in diameter. The length of each section is 2¼ in., making a total for the stator of 4½ in.

The rotor may be any convenient size, ½ to ¾ in. less in diameter than the diameter of the stator tube. The wire used for winding both the rotor and stator sections may be any size between No. 24 and No. 20 single cotton covered. The rotor is pivoted so that it is between the stator windings.

In order to concentrate the windings as much as possible, it is desirable to use a bank winding of two layers on the stator coil. This type of winding is no more difficult than the ordinary method of winding single layer coils.

Start winding the coil in the usual manner for the first three turns. Then, instead of winding the fourth turn next to the third, carry the wire up at the end of the third turn and wind it so that the turn lies on top of and between the second and third turns. The fifth turn is brought down at the end of the fourth turn so that it lies beside turn No. 3. The sixth turn is then brought up so that it lies on top of and between turns Nos. 3 and 5 and beside No. 4, and so on.

In making taps you will find it easier to tap off only on the turns of the top layers. If you have started the top layer with the fourth turn, each sixth turn will be on the top layer. The taps can easily be made by twisting the wire in a small loop at the point where the tap is to be made, baring the wire at that point, and soldering the twist so as to prevent it from untwisting.

Care must be taken that the bottom turns are wound on tightly in order to prevent any possibility of the top turns' wedging down between them. The taps should not be taken at exactly the point where the wire is brought down from the top to the bottom layer or vice versa but should be taken a short distance after the wire is brought up to the top layer or a short distance before it is brought down to the bottom layer.

Drilling for the Rotor Shaft

A short piece of brass 1/16 by ⅜ in., or any other convenient size, is bolted on the front inside part of the stator tube sections and another piece is placed at the back, to keep the two parts lined up and together. Holes the size of the rotor shaft are drilled to provide bearings for the rotor. The sections are assembled after being wound.

If the new dry-cell tube that operates on 3 volts and consumes .06 amperes is used, it will be necessary to provide three 1½-volt dry cells in series to provide the filament current. In this case the ordinary standard type of filament rheostat cannot

(*Turn to page 92*)

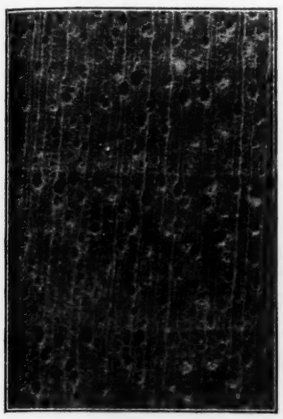
Assembling a High Power Microscope

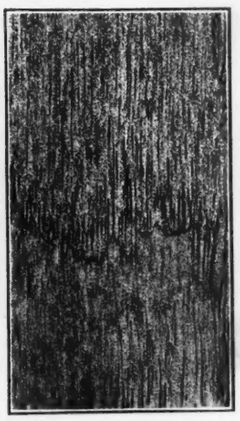
How to Identify Walnut and Mahogany

By James S. Godfrey

CAN you always identify walnut and mahogany when you see them? And do you know offhand the difference between a piece of burl walnut veneer and a crotch figure, or what distinguishes fiddleback from striped mahogany?

To know these two greatest of cabinet woods intimately and recognize them in their various forms and figures is a valuable accomplishment. Everyone who is interested in furniture—and who is not?—should have this knowledge. The home worker, who has little choice but to use either walnut or mahogany for his finer pieces of wood-craftsmanship, is certain to find useful every scrap of information he can pick up regarding these woods.



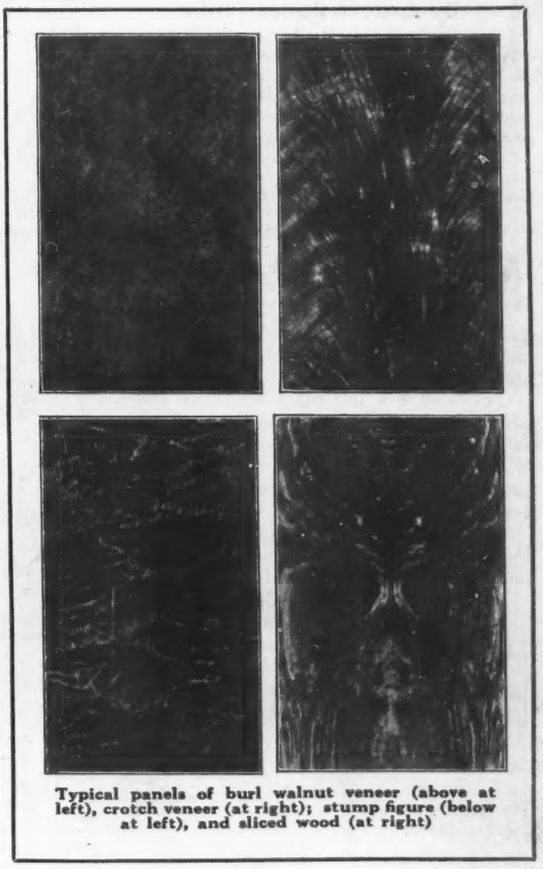


Microphotograph of the end grain of black walnut magnified 7½ times (above) and the flat grain of walnut (at right)

Photographs furnished by Forest Products Laboratory, U. S. Forest Service

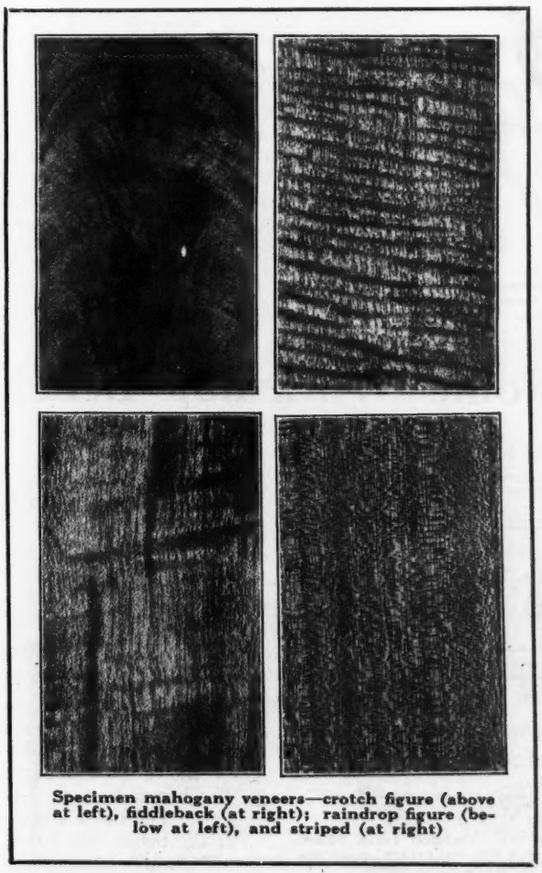
The first essential is to be able positively to distinguish walnut and mahogany from other woods. To depend upon the superficial appearance of the finished surface of the wood is hazardous. Even experts can be deceived momentarily by cleverly treated substitutes. There is, however, a reliable test for both walnut and mahogany in the size and arrangement of the "pores" or small tubes found in the cross section or end grain of the wood. These can be seen with the unaided eye although a magnifying or reading glass is useful in studying them. If possible the end grain should be sliced very smoothly with a keen blade before examination.

Microphotographs of the end grain of black or American walnut and true mahogany magnified 7½ times, appear on this page. They are published through the courtesy of the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture. Mr. Arthur Koehler, who is in charge of the Office of Wood Technology, very kindly lent his assistance in the preparation of this article.



Typical panels of burl walnut veneer (above at left), crotch veneer (at right); stump figure (below at left), and sliced wood (at right)

Note carefully the size of the pores and their arrangement. Then turn to page 105 and examine the microphotographs of yellow birch and red gum. These two excellent hardwoods are the two woods most commonly used as substitutes for walnut and mahogany. Their texture in the cross section is so very much finer, however, that there is no chance of mistaking them for walnut or mahogany.



Specimen mahogany veneers—crotch figure (above at left), fiddleback (at right); raindrop figure (below at left), and striped (at right)

Pores Always Visible

These characteristic pores of walnut and mahogany appear on the flat surfaces as fine but rather long lines, as seen in the two photographs of the plain wood on this page. When the log is cut diagonally, as the specimen of walnut shown in the upper illustration on page 105, the pores appear as short dashes, but they are still quite distinct. In fact the pores are always present, no matter how bold the figure of the grain or how light or dark the finish.

While more than sixty different species of timber have been sold as mahogany at one time or another, the lumber now ordinarily sold as mahogany is either true mahogany from tropical America, "African mahogany," or "Philippine mahogany." The first two are distinguished by a dark amber-colored gum partly filling the pores. True mahogany has continuous, light concentric lines on the cross section usually from ⅛ to ½ in. apart, as shown (enlarged) in the microphotograph while "African mahogany" never has these lines. "Philippine mahogany" has no dark masses of gum, but has fine white tangential lines that under the magnifying glass appear as rows of small openings filled with a white material.

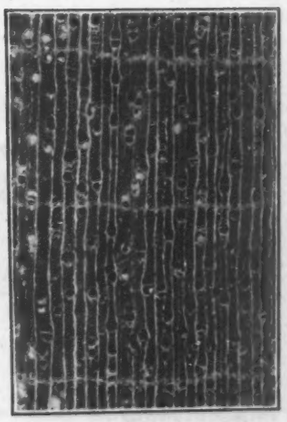
Both walnut and mahogany furnish splendidly figured veneers. These are used for decorative purposes in fine furniture and cabinet work.

Four typical figures of each wood are shown on this page. There is a speci-

(*Turn to page 105*)

Flat grain of mahogany (above) and microphotograph of the end grain (at the right)

Photographs furnished by Forest Products Laboratory, U. S. Forest Service



Assembling a High Power Microscope

By Ernest Bade, Ph.D.

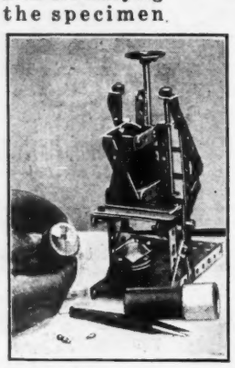
NO instrument is more important in the home laboratory than a microscope; few instruments are more expensive. We therefore asked Dr. Bade to design one that could be made without much technical skill or any large outlay of money, and the result is the remarkable instrument described in this article.
—THE EDITOR.

MAKING the stand for this microscope is really the most difficult part of the work. In this case toy construction parts have been used but plain metal strips or wooden parts will serve the purpose.

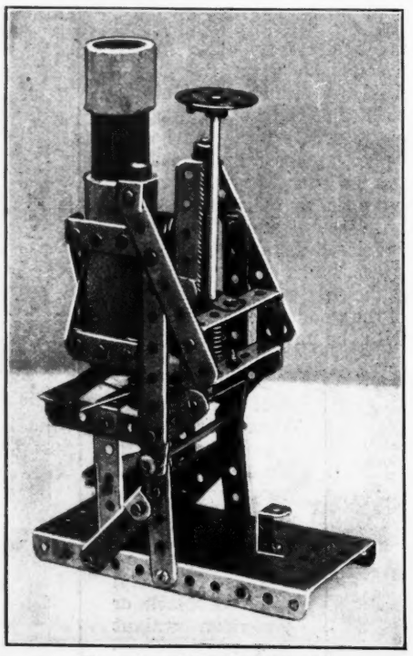
The base is a flat plate with two short arms rising from the center of both long edges. The tops of these arms are provided with holes through which a rod is later passed to carry the upper part of the microscope.

The upper part consists of a shelf, a hollow square for holding the microscope tube, and a micrometer screw for moving it. Care must be taken that the shelf for carrying the specimen will lie directly beneath the tube. For illumination a large hole must be left or made in this shelf since a mirror is placed on the base to light up the object that is to be viewed. The shelf is also provided with an upright to which the micrometer screw is attached. In this case the screw is a toy worm gear, although a rack and pinion could have been used as well. The shelf is hinged to the base by the rod already mentioned.

How the objective lens is made (above) and mounted (at right)

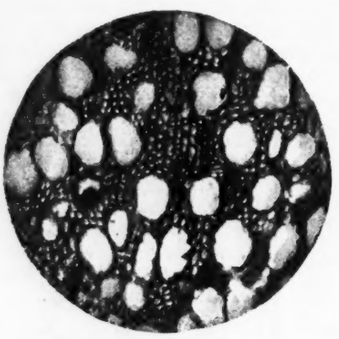


The sliding tube holder, which is held in place by two rods on which it slides, has a rack with teeth that mesh with the worm. Therefore, by turning the worm, the holder can be raised or lowered as desired.



Rear view of the finished microscope (above) and the instrument tilted to obtain direct light (at right)

The microscope tubes are made of heavy paper or cardboard. The outer and larger tube is attached to the hollow square so that it is immovable. Into this a short tube is fitted; it must be quite firm. The lower end is covered with a cardboard ring through the center of which a small hole is burned with a hot needle. This is the nose piece, or objective. For the eyepiece, or ocular, another tightly fitting tube is made, as long or longer than the outer tube.

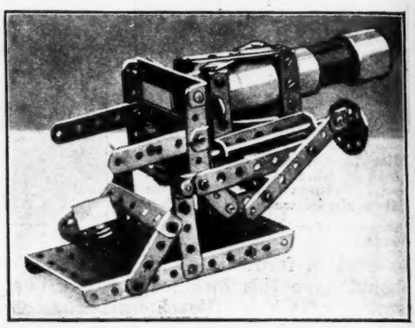


Taken with the microscope, this photograph shows the structure of a piece of wood enlarged approximately 75 times

The lens for the nose piece must have a short focus, if it is to enlarge to any great extent. Since such an objective is exceptionally expensive, it is just as well to make a substitute at home, although the results will not compare with those obtained by the use of a real lens.

Take an ordinary thin glass rod or a glass tube and, holding it over a bunsen burner, melt the end into a small round ball. Draw the melted ball away from the rest of the glass with a pair of forceps, taking care that the ball remains perfect. This ball is to act as the lens in the nose piece.

It is more than probable that the first ball will not be perfect, nor will the second or



third, but at any rate try them and if they do not work, make some more. This is quite easy to do, does not take long, and one out of a dozen will do the trick nicely.

The glass ball is pasted over the hole burned in the disk. Take care not to soil this ball and do not paste any paper over or in back of it.

The eyepiece can be any short focus lens, a focus of approximately 2 in. being sufficient. Attach this to the lower part of the upper inner tube and begin focusing by gently raising or lowering this tube until a large field of light is obtained. It may be necessary to lift the eye 6 in. or more from the eyepiece to get results. By experimenting with several old lenses at hand, you may succeed in making a compound eyepiece.

Pipe Frame Supports Motorized Home Workshop Bench

By Frank N. Coakley

COMPELLED to use a corner of the cellar or garage or some equally restricted space, the amateur machinist is often at a loss as to the best method of arranging his bench and machine tools.

A compact and efficient layout, making use of a framework of pipe and pipe fittings, is that illustrated in Fig. 1. The combination bench with a 10 in. lathe, a 10 in. drill press and a bench grinder take up less than 40 sq. ft. of floor space.

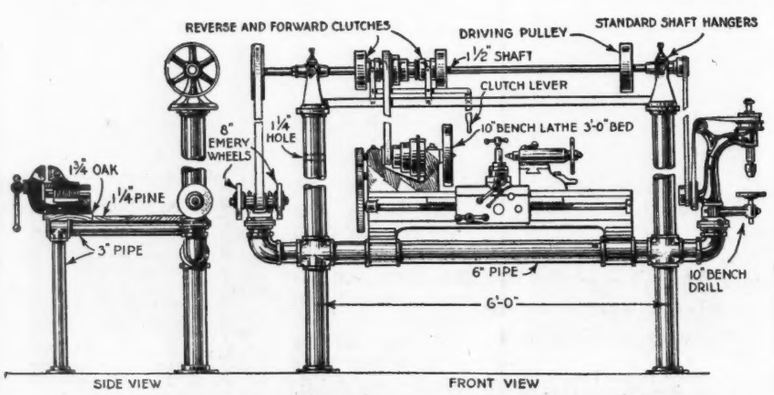
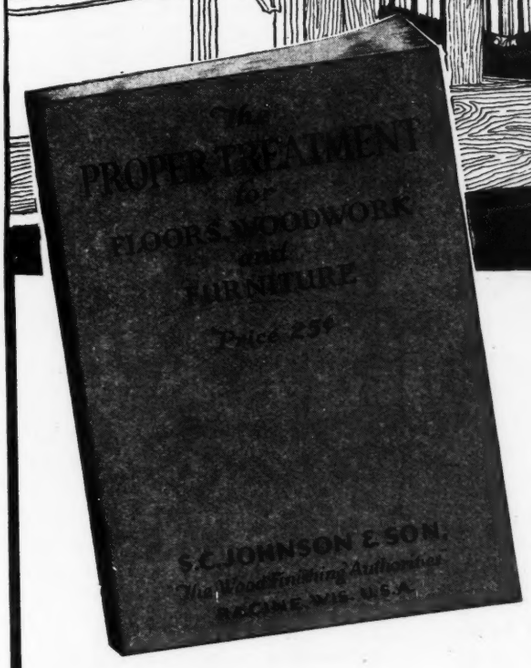


Fig. 1. Side and front views of the motorized workbench arranged for a 10-in. bench lathe, a bench drill, and a grinder, together with the necessary countershaft. The entire bench requires less than 40 sq. ft. of floor space

For the lathe shown, the standards are 6-in. pipe. A smaller machine would not require such heavy supports. Standard shaft hangers generally give better satisfaction than the usual amateur arrangement of babbitted pipe tees.

The bench frame is connected to the machine stand by means of 3-in. pipe flanges bolted to the 6-in. standards. The bench legs are 3-in. pipe. The outside board of the bench top is 1¾-

(*Turn to page 101*)



This Beautiful Book on Wood Finishing FREE

GIVES complete instructions for finishing all wood—hard or soft—old or new. Explains just what materials to use and how to apply them. Tells how inexpensive soft woods may be finished so they are as beautiful as hardwood. This book is the work of experts—illustrated in color. Gives covering capacities, etc.

JOHNSON'S WOOD DYE

Johnson's Wood Dye is for the artistic coloring of all wood. With it inexpensive softwoods may be finished so they are as beautiful and artistic as hardwood. Johnson's Wood Dye is very easy to apply—it dries in 4 hours and will not rub off or smudge—penetrates deeply bringing out the beauty of the grain. Made in fourteen popular shades all of which may be easily lightened, darkened or intermixed. Full instructions on every label.

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Better Shop Methods

How Expert Mechanics Save Time and Labor

Unique Bench Grinder Has a Variety of Uses

A Six-in-One Machine of Simple Construction that Does Tool and Side Surface Grinding, Hand Milling, Drilling, Wood Turning and Buffing

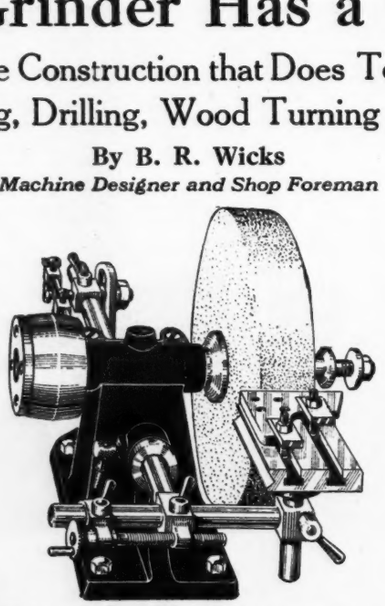
By B. R. Wicks

Machine Designer and Shop Foreman

FOR the countless small grinding jobs that all machinists and bench hands meet in the ordinary course of their shop work, the 6-in. bench grinder illustrated is, I feel confident, one of the most unique and useful machines of its kind.

Resembling in main essentials an ordinary bench grinder, it is a many-purpose machine. It not only serves for the grinding of lathe and other machine tools, but it easily accomplishes the side surface grinding of small work within limits close enough for most practical purposes, and, with equal facility, handles light hand milling operations. On occasion it also does drilling, wood turning and buffing.

A glance at the assembly drawings below will tell any machinist the possibilities of the machine much quicker than columns of explanation. While it is in no way intended to replace larger and more accurate machines, the grinder has a wide field in performing small odd jobs that are essentially bench operations—the kind of work that often ties up a large and expensive machine that could profitably be used for more important purposes.



The complete grinder, showing the grinding table in use. The table is supported, when necessary, by an adjustable leg, indicated in the end view below

Valuable for Automobile Repairs

Aside from its value in the shop, this grinder obviously is an exceptionally useful tool for the home machinist, model maker and automobile repair man. They are frequently handicapped for lack of facilities for doing the surface grinding and milling that is so easily accomplished with this grinder.

The base casting, 1, which is detailed on a following page, is simply a development of a conventional bench grinder base. It is cast iron, finished as marked. The pattern can be somewhat simplified by making the bearing for the motion link belt shaft, 37, separately, and welding or screwing it in place.

The spindle, 3, which is machine steel, runs in a bronze spindle bushing, 2, and is keyed at one end to a special cast iron driving pulley. This pulley, 9, is designed to take a faceplate up to 12 in. in diameter for a considerable variety of wood turning and turned pattern work. How this is accomplished is indicated diagrammatically on another page.

The spindle is not only equipped to hold a 6- or 7-in. emery wheel, but also has a No. 1 Morse taper for use in various ways. The auxiliary arbor, 7, of tool steel, is inserted in the main spindle for holding small wheels, milling cutters, saws and the like when necessary.

Perhaps the most unusual feature of this bench grinder is the adjustable sliding grinding table for side surface grinding, 41. It can be set at an angle either way, and is provided with T-slots and stud holes. Handy attachments for straight and taper work may be added, and the table serves for either grinding or milling.

The table spindle, 42, is graduated for convenience in setting the table at an angle, and is locked in relation to the table slide, 21, by the binder, 29, and tightened by the handle, 25. The grinding table is supported by the adjustable support shown in the end assembly view. This is to relieve the strain on the cross slide, 19.

The table slide, 21, is a sliding fit in, and feather-keyed to, the horizontal cross slide 19, and a screw feed is provided by the simple arrangement shown most clearly in the top assembly view.

Swivel and Slides Give Flexibility

The cross slide, 19, travels in the cross slide swivel, 18, which is graduated and can be set at an angle. This swivel is held in position in relation to the frame by the binder, 15. The cross slide is held in relation to the frame by the screw 12, and thrust block, 13.

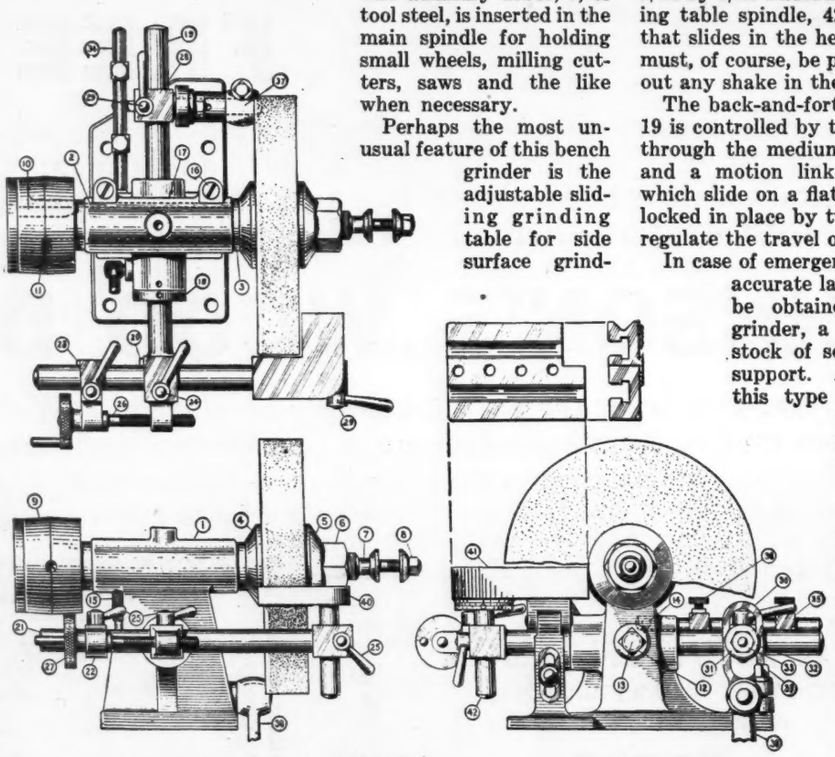
It will be noted that the alinement of sliding parts is maintained throughout by keys and keyways. Both 19 and 21 have 3/16 by 3/16-in. feather keys, and the grinding table spindle, 42, a ⅛-in. square key that slides in the head of 21. These keys must, of course, be perfect sliding fits without any shake in their keyways.

The back-and-forth stroke of cross slide 19 is controlled by the operating lever, 38, through the medium of a short shaft, 37, and a motion link, 30. Two dogs, 35, which slide on a flattened rod, 34, and are locked in place by two 3/16-in. screws, 36, regulate the travel of the stroke.

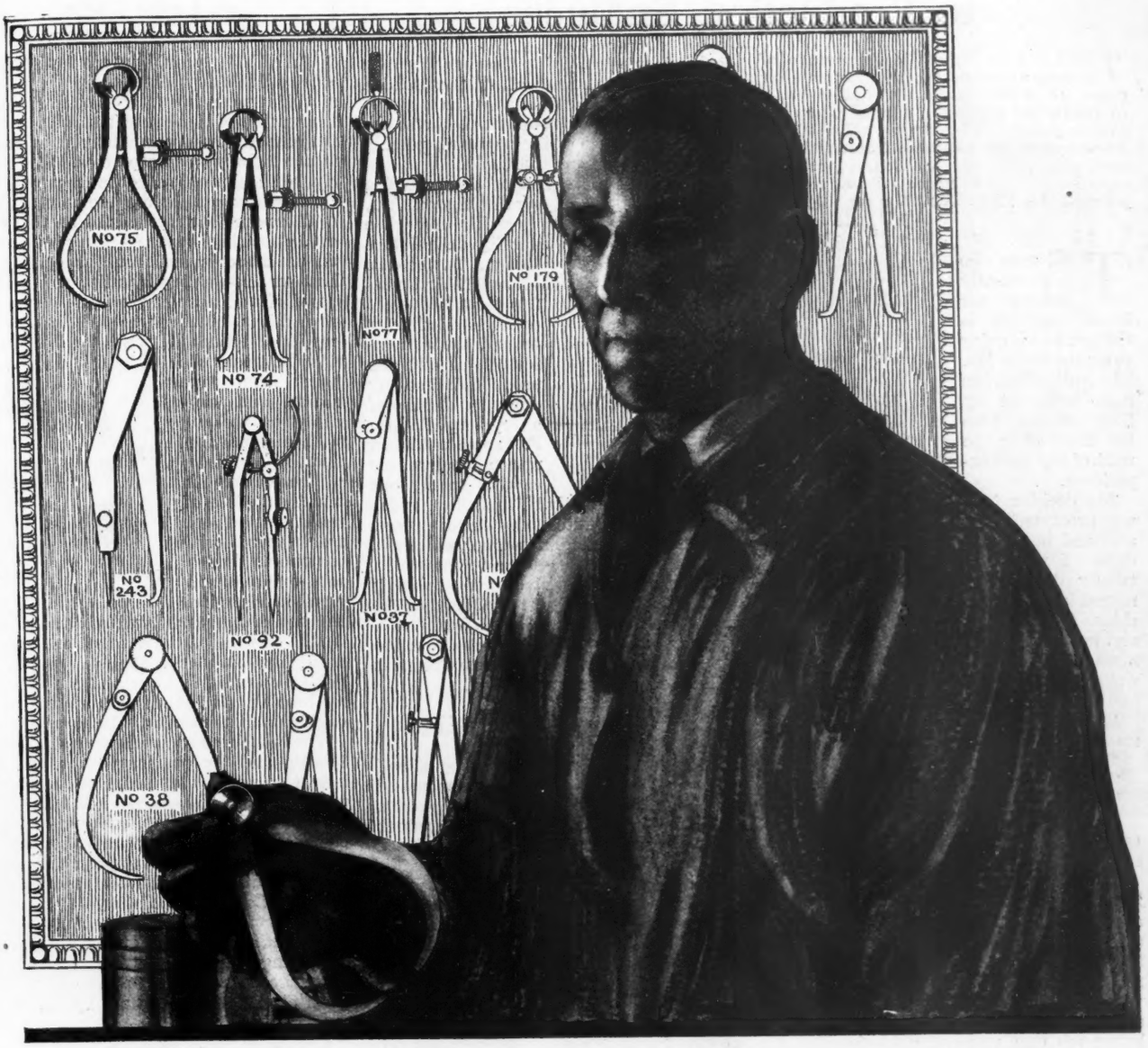
In case of emergency, a useful and fairly accurate lathe for small work can be obtained by mounting the grinder, a toolpost, and a tailstock of some kind upon a firm support. A bench machine of this type should preferably be mounted not directly on a wooden bench but upon an iron plate.

Work-holding and guiding attachments of a type similar to those used on larger machines can readily be made up or improvised as occasion arises. Some work will require a small angle plate. One 1½ by 2 in. is a good size. A straight edge or an adjustable straight edge for taper work, 2¼ in. long, is

(*Turn to page 86*)



How the grinder parts, which are detailed on following pages, are assembled. The conventional tool rest for ordinary tool grinding, is shown in the front and top views, and the special swiveling table with its supporting leg appears in the end view. Note the table operating lever, 38



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From Machine Shop Apprentice to Production Engineer

THIS is another striking message of encouragement for mechanics that came to POPULAR SCIENCE MONTHLY in its recent contest, "How I Got that Better Job." The writer, who is well known and contributes frequently to technical magazines, asked, for personal reasons, that his name should not be published.—THE EDITOR.

Ready to quit

THE man who is constantly looking for better methods is the one who is going to get the better job. The truth of this has been indicated by little flashes here and there along the road of my own experience.

My decision to go after the better job was prompted by my spoiling some valuable and important work in my 'prentice days. I was planing three surfaces on twenty duplex steam pump bodies, arranged in a triple line on the bed of the machine. These had to be exact in total height and in relation to each other. That day I must have been dreaming, for suddenly I woke up to the fact I had cut down too far and spoiled all twenty castings.

Impetuous by nature, I got my coat and, ready for the road, approached the boss.

"Where are you off for?" he demanded.

"Home," I answered.

"Sick?"

"I guess so. You see, I've spoiled the castings I was working on, so I thought I'd save you the trouble of firing me."

After a pause of several years seemingly, he said: "You young fool, take off your coat and hat, and throw those castings into the scrap heap. Put another batch on, and heaven help you if you spoil them! And remember this," he continued: "The man who never spoiled anything, never made anything, but see to it that you do a better job than you ever did before."

That night I made up my mind to prove to my boss that I could do a better job, with the result that in two weeks I was able to suggest to him the idea of a fixed step gage that resulted in quicker work, with less chance of error.

From then on I decided to find better methods of doing things. For example, there was often confusion and wasted time in handing out orders, so I suggested a series of six files mounted on a board, with the most important rush job mounted on file No. 1. The men were told to take the order on the lowest number.

Ingenuity Solves Many Problems

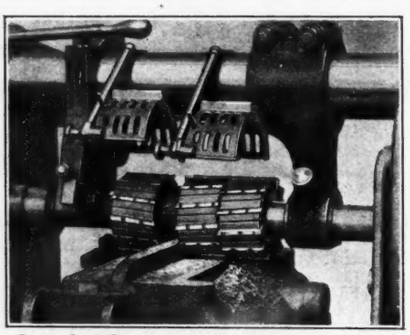
On another occasion a leak developed in the water main but it was not desirable to shut the water off to make the repair and I suggested a way it could be done. The next time it was a new method to slot the heads of round head screws, of which we made a great number. I designed a simple form of milling machine with a sliding carriage and a boy in the tool inclosure room operated it in his spare time.

"Do as quickly as you can, all the operations possible," became my motto. We then had a number of shafts to turn, which required two cuts. The lathe operator used one tool at a time, but I rigged up a double toolpost, one tool doing the roughing cut; the other, the finishing cut. This same idea was developed in various ways, as many as six tools being used at one time. I also applied the idea to milling cutters, placing them in gangs wherever I could.

About this time I moved up to the drafting office, spending my time on jig and fixture design. In the case of a cylindrical casting that had eight evenly spaced holes around the circumference, I cut the production time way down by the use of a very simple fixture. For some unknown reason the firm was content to lay out each casting separately before drilling and it took a man 15 minutes to lay out one piece. I mounted the casting on an arbor, which was inserted in a block having a tongue on it. This in turn was mounted on the main jig casting, which had eight radial slots cut in it. After drilling one hole, the operator, a boy, not a man, pulled the block out of the one groove and moved it on to the next until all eight holes were drilled.

Cutting Down Handling Costs

After several years in the drafting office I was made assistant chief, and later moved to another firm as chief. In this plant a huge basement was used for storing stock parts. Unfortunately, there was a brick wall partitioning off a certain part of this basement and, when it was necessary to take parts from one section to the other, the usual practice was to put them on a hand truck, take them up the elevator, across the plant and down another elevator.



Several tools are used simultaneously whenever possible, as in the case of this gang milling set-up

"Why not knock a hole in the wall, and make an archway?" I thought. The simplicity of the idea was almost ridiculous, yet it saved a large sum of money.

I left that firm to go to a position as manager of the works; then, still in search of better things, I moved on to engineering service work.

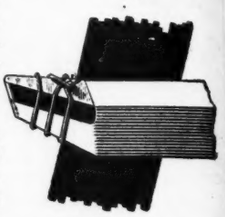
My advice is: Keep your eye on the better job. Read good magazines. Keep up with the times. Don't work according to the time clock. Get away from the idea you are giving your boss too much time and too much profit.

We are always learning, and if we keep an open mind, we always will learn—learn to do and to get that better job.

Brazing High Speed Steel Tips on Lathe Tools

MANY shops could get along with fewer solid lathe tools made of high-speed steel if it were thoroughly understood that the brazing of high-speed steel tips to ordinary machine steel or mild tool steel bodies is a relatively simple process. The principal difficulty comes in the slipping of the tip from its seat before the flux has set.

There are four methods of brazing that can be used in the average shop; brazing by the use of a commercial brazing compound, heat- or fire-welding by using a flux composed of a mixture of powdered borax and steel filings, brazing with a thin sheet of copper or brass and powdered borax as a flux between the point and the shank, and oxy-acetylene welding with any suitable flux.



Tip bound on ready for preheating

The shank is usually a piece of machine steel cut from commercial bar stock, although mild tool steel will give better service. The end of the shank is milled to a suitable depth and the tip, which is high-speed steel, is cut from bar stock. It should be surface ground on one side to present a clean face for brazing. If the surfaces are not thoroughly clean, the tip is apt to become loose.

The brazing compound is placed between the tip and the shank and the two are bound together with soft iron or copper wire. Brazing is accomplished in a high-speed steel furnace, preferably one with a chamber for preheating and another for bringing the tool up to the proper temperature for hardening. If this type of furnace is not available, the tools may be preheated in any furnace.

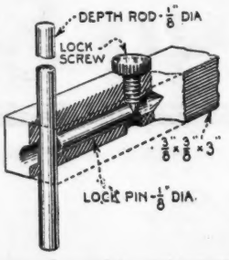
Preheating is necessary to enable the flux or brazing compound to flow readily over the entire surface, and also to avoid cooling down the high-speed furnace by the introduction of cold steel.

The parts, wired together, are placed in the first furnace or chamber and brought up to a dull red heat. When removed, the tip should be tapped lightly with a hammer to distribute the flux evenly between the surfaces. The tool is then placed in the high-speed furnace and brought to the correct heat for hardening. Care should be taken to see that the tip does not float from its seat while this is being done. When the correct temperature has been reached, the tool is removed, cooled and ground to shape.—H. L. WHEELER, Westwood, Mass.

Simply Made Depth Gage

THE simple depth gage illustrated has a certain originality about it that will appeal to men who make their own tools.

The body is ⅜ in. square steel about 3 in. long. Three holes are drilled in it, as shown, one of them being tapped for a 3/16 in. locking screw. The depth rod and locking pin are only short lengths of ⅛-in. drill rod. The locking screw has a tapered point.—C. M. W.



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This nation-wide construction, this large expenditure of funds, could not be carried out efficiently or economically by unrelated, independent telephone organizations acting without co-operation in different sections of the country. Neither could it be carried out efficiently or economically by any one organization dictating from one place the activities of all. In the Bell System all the associated companies share common manufacturing and purchasing facilities which save millions of dollars annually. They share scientific discoveries and inventions, engineering achievements, and operating benefits which save further millions. But the management of service in each given territory is in the hands of the company which serves that territory and which knows its needs and conditions.

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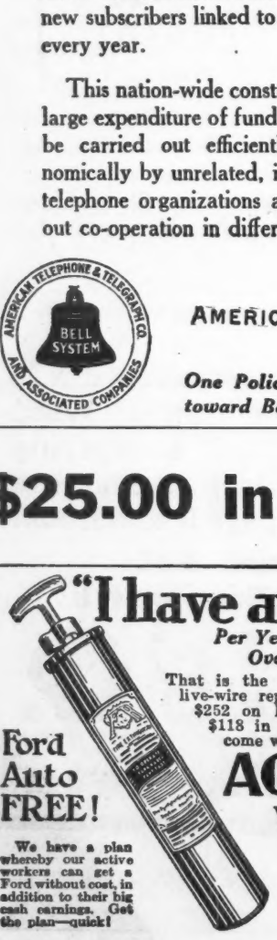

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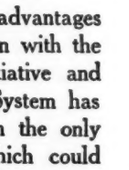
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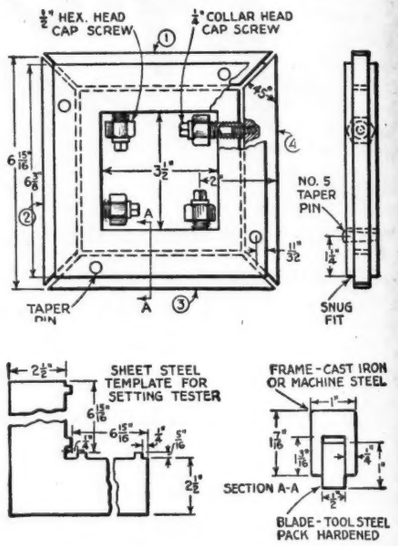
Square Tester Is Useful Toolroom Checking Fixture

By Henry S. Laraby

WHILE the cylinder method of checking squares is popular with mechanics because the cylinders can be carried around in their toolkits and take up little room, something larger is required in the toolroom for setting squares and testing various precision tools.

An excellent form of such a square tester is illustrated. The blades are adjustable and can be reset at any time without much difficulty or expense. Slots for the blade should be carefully finished to the exact size without any play. The tapping also should be carefully done so that the screws are tight and yet can easily be turned with a wrench.

The frame can be made of cast iron or machine steel left soft or tool steel pack hardened. In the latter case, the slots can


½" HEX. HEAD CAP SCREW
¼" COLLAR HEAD CAP SCREW
NO. 5 TAPER PIN
TAPER PIN
SNUG FIT
SHEET STEEL TEMPLATE FOR SETTING TESTER
FRAME - CAST IRON OR MACHINE STEEL
SECTION A-A
BLADE - TOOL STEEL PACK HARDENED

Details of the square tester and the templet used for setting and checking it

be ground out. The plates are tool steel, pack hardened, and ground to fit the slots. The blades should be numbered so that they may be tried in rotation when setting the tool.

The method used in setting the square correctly the first time is by means of a sheet metal templet, made as shown, and as perfectly square as possible. Blades 1 and 4 are then set with its aid and the other blades adjusted, working around from blade 1. When blade 4 is again encountered, any noticeable error will be four times the error at blade 1.

The templet is then altered and the blade set again until all the angles are exactly 90 degrees, after which the tool is ready for use in testing other squares. The templet should be kept in a box with the square for reference.

If the square testing frame is made of tool steel and pack hardened, it will be black in color, and with the brightly polished ground and lapped blade will present a handsome appearance. A hardwood case with a cover should be made for it.

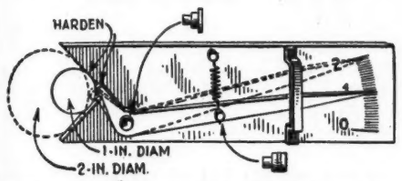
Making an Oilstone Cut Fast

AN OILSTONE will cut much more quickly if fine emery powder is "worked" into it by rubbing it in the abrasive on a cast iron block.

Measuring Diameters with a Self-Registering Indicator

CALIPERS and a scale are used ordinarily for measuring the diameter of shafts unless a micrometer large enough for the purpose is at hand.

The caliper method is slow and the micrometer method is useful only for stationary shafts. As a substitute, the tool illustrated will measure quickly either a revolving or stationary shaft or circular part.



Either stationary or revolving shafts or cylindrical parts can be measured with this gage

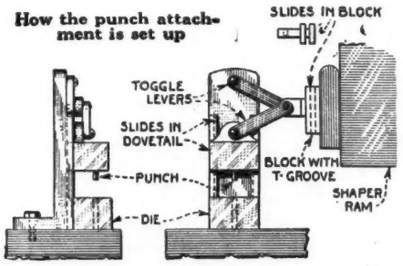
A 90-degree V groove is cut at one end of a steel plate and an indicator is pivoted as shown, to bring the head near the center of the notch. The long arm of the indicator registers opposite a scale, which is calibrated by standard plug gages. The contact faces should be hardened.—G. A.

Shaper Serves as Punch Press

TO FILL an order for a larger number of small metal parts, in each of which several holes were required, the foreman of a small machine shop rigged up a shaper to serve as a punch press, as illustrated.

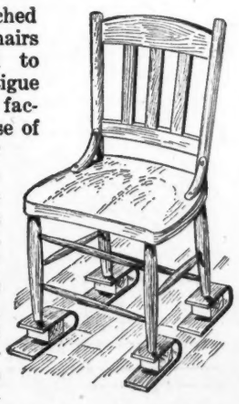
The die, bolted to the shaper table, carries at its back a heavy plate with a dovetail groove in which the punch block slides. This block is attached to one end of a toggle joint, the center of which is fastened to the shaper ram by means of the sliding arrangement shown. As the shaper ram moves forward the toggle causes the punch to descend.—R. H. KASPER, Philadelphia, Pa.

How the punch attachment is set up



Chair Springs Reduce Fatigue

SPRINGS attached to the legs of chairs have been found to counteract the fatigue felt by workers in factories where the use of heavy machinery causes a certain amount of vibration. Operators who do assembling, testing, and similar tasks while seated at a bench, find the vibration tiresome and annoying. These springs reduce fatigue effects to a minimum.—A. M.



Springs absorb the vibration and prevent its tiring effects

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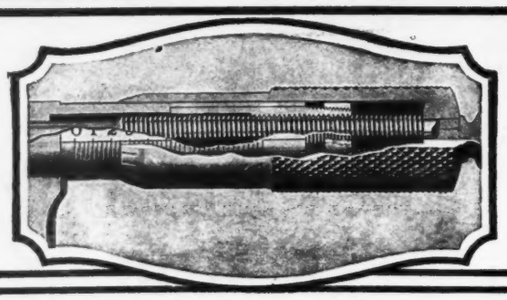

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Watch for point 2. It will appear soon in this magazine

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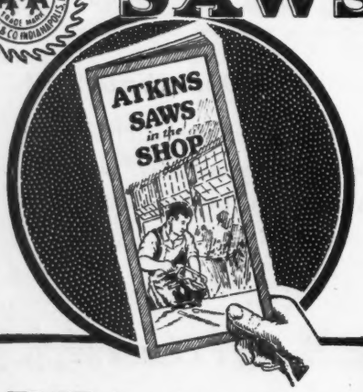
ATKINS METAL CUTTING SAWS



FREE Book on Saws

This book, just off the press, gives all the latest information on saws. Tells how to speed up metal-cutting and get longer and better service from your saws. Gives complete information on selecting the right saw for every job. Shows Atkins metal-cutting saws and machines, and explains their use. Also, contains scores of helpful hints and tables.

This book is based on the experience of practical saw makers and users. It is valuable to every man who uses or buys saws for cutting metal. Send for it NOW.

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Radio Head Sets

Are balanced as to volume—both ears get the message.

This means that the receivers are mated—a feature which permits the users enjoying the sensation of hearing equally well from both receivers.

Stromberg-Carlson Head Sets have three more distinctive features, which you will like:—

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3. The adjustment rod telescopes, therefore it does not catch the ladies' hair.

Order Stromberg-Carlson apparatus through your electrical dealer or write us for free bulletin No. 1029-PS.

Stromberg-Carlson Telephone Mfg. Co.
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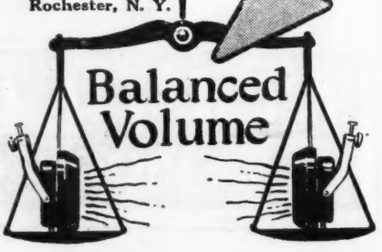
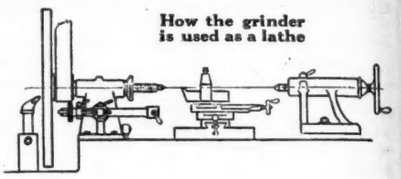


Unique Bench Grinder

(*Continued from page 80*)

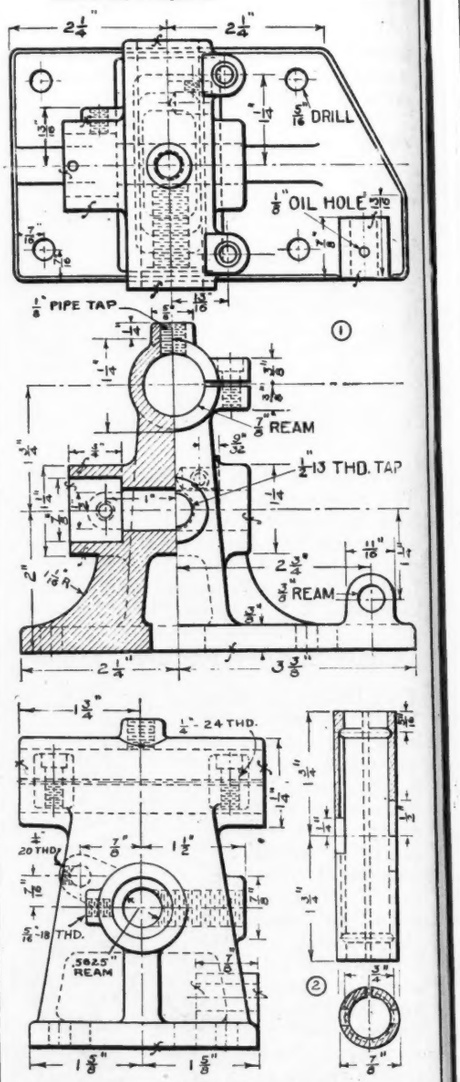
a valuable accessory and, of course, screw plugs will be required. The details of these parts are omitted, as little difficulty should be experienced in making them up as necessary.

How the grinder is used as a lathe



The complete bill of materials for the grinder itself is as follows:

1	Frame, cast iron, finish as marked
2	Spindle bushing, bronze
3	Spindle, machine steel
4	Fixed flange, cast iron
5	Loose flange, cast iron
6	Spindle nut, machine steel, case hardened
7	Arbor for small wheel, tool steel
8	Arbor flange and nut, machine steel, case hardened
9	Spindle driving pulley, cast iron
10	Spindle driving pulley key, cold rolled steel
11	Spindle driving pulley retaining screw, tool steel, hardened
12	Thrust block binding screw, tool steel, hardened
13	Thrust block, cold rolled steel
14	Retaining screw for dog slide, tool steel, hardened
15	Cross slide swivel clamp screw, machine steel
16	Spindle adjusting screws, machine steel, case hardened, 2 required



The main frame, fully dimensioned for constructing the pattern and machining the casting, and detail of the bronze spindle bushing

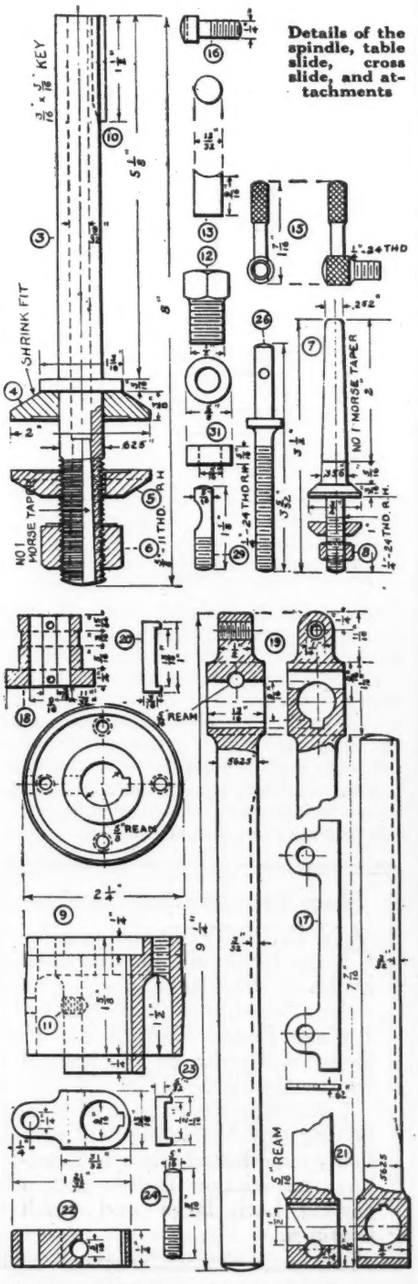
Unique Bench Grinder

17 Shim for spindle adjustment, sheet brass
18 Cross slide swivel, machine steel
19 Cross slide, machine steel
20 Cross slide key, machine steel
21 Tool and table slide, machine steel
22 Feed screw clamp, machine steel
23 Feed screw clamp key, machine steel
24 Slide binders, machine steel, 2 required
25 Slide binder handles, bronze, 4 required
26 Feed screw, machine steel
27 Feed screw hand wheel, machine steel
28 Cross slide head, machine steel
29 Cross slide head binder, machine steel
30 Motion link, machine steel
31 Motion link roll, tool steel, hardened
32 Motion link roll washer, machine steel
33 Motion link roll nut, machine steel, case hardened
34 Stroke adjusting dog slide, cold rolled steel
35 Stroke adjusting dogs, machine steel, case hardened, 2 required
36 Dog adjusting screws, machine steel, case hardened, 2 required.
37 Motion link shaft, cold rolled steel
38 Operating lever, cast iron, file finish
39 Operating lever binding screw, machine steel, case hardened
40 Tool rest and spindle, cast iron and machine steel
41 Grinding table, cast iron
42 Grinding table spindle, machine steel
43 Grinding table binding screws, machine steel, case hardened, 2 required

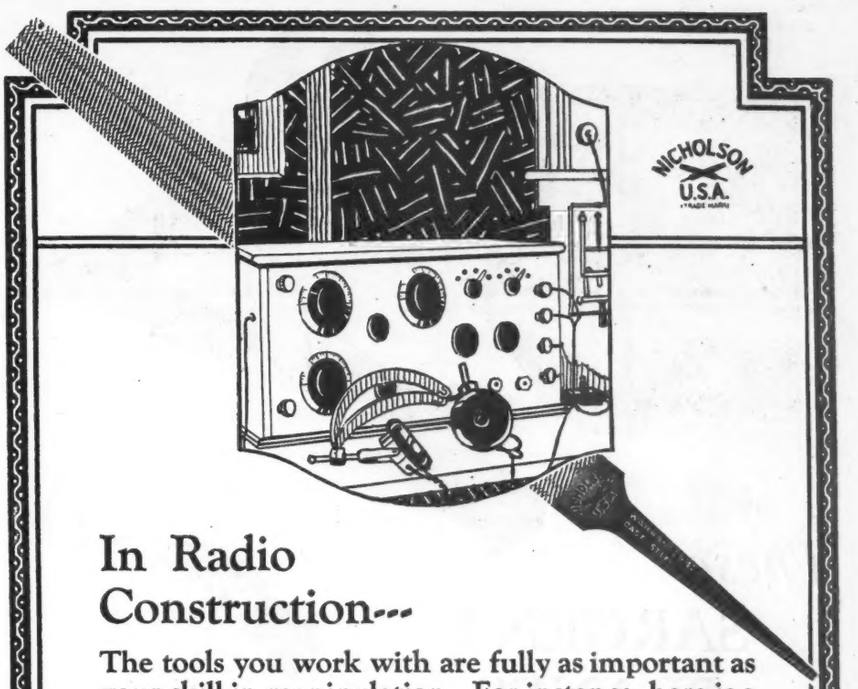
All parts are finished all over except as otherwise noted.

These parts are shown in the accompanying details except No. 14, a headless ¼-in.

(*Turn to page 88*)



Details of the spindle, table slide, cross slide, and attachments



In Radio Construction---

The tools you work with are fully as important as your skill in manipulation. For instance, here is a group of files that all radio builders actually need:

NICHOLSON 8″ Round File--- for enlarging holes in panel boards.

NICHOLSON 10″ Half Round Bastard File---for smoothing peep holes in panel.

NICHOLSON Tungsten Point File---for surfacing contact points.

NICHOLSON 6″ Flat Bastard File---for miscellaneous work.

NICHOLSON 8″ Cabinet File--- for finishing ends and edges of wooden cabinets.

NICHOLSON 10″ Flat File--- for smoothing panel edges and beveling.

Whatever the filing requirement, there's a NICHOLSON File for the job. Skilled mechanics and wood workers prefer NICHOLSON Files because their sharpness, accuracy, uniformity and endurance assure better results.

Be sure the name NICHOLSON is stamped on the tang of every file you buy

NICHOLSON FILE Co
PROVIDENCE, R.I., U.S.A.

NICHOLSON FILES
-a File for Every Purpose

These
SARGENT
PLANES
belong in every workshop

PERHAPS it's a new radio cabinet nearing completion, or it may be only a bureau drawer that's been sticking! But whatever it is—if it's made of wood and needs smoothing or finishing—the Sargent is the plane that will do the job right, in a jiffy.

The Auto-Set Bench Plane makes shavings fly. With, against, or across the grain, it cuts the wood without hesitation. It is light, true, keen, time-saving—unsurpassed where the job is difficult.

The Sargent Steel Block Plane is particularly good for 'cross grain and end work because of the low angle arrangement of cutter. It is light, unbreakable, indestructible, and a capable finisher.

And lastly comes *The Sargent Steel Pocket Plane*, so often called "the craftsman's pet." And a more practical and useful favorite never existed. It cuts like a veteran, is true as a watch, and in close quarters proves its great convenience.

Your workshop is incomplete without these tools of the master craftsman. For detailed information concerning them and other kinds, write for the Sargent Book of Planes and see these models at any good hardware dealer's.

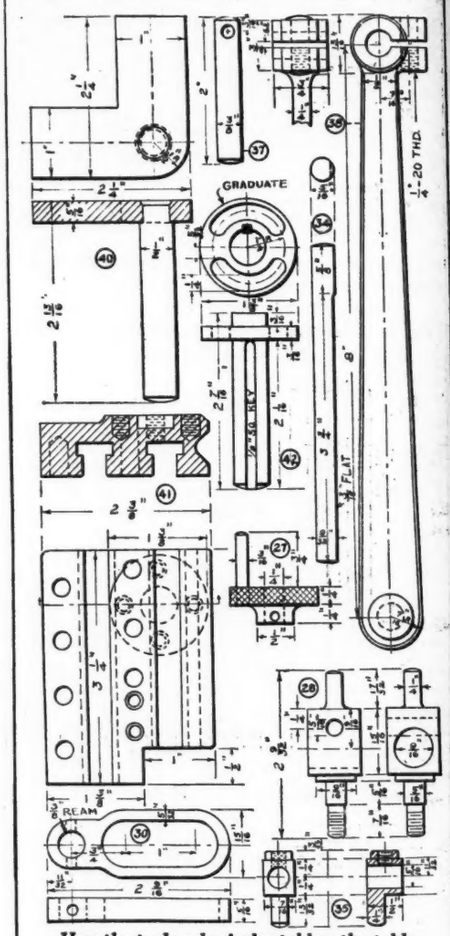
SARGENT & COMPANY
Hardware Manufacturers
50 Water Street New Haven, Conn.

SARGENT
Tools & Hardware

Unique Bench Grinder

(*Continued from page 87*)

20-thd. setscrew; No. 25, 4 binding levers to fit the 5/16-in. slide binders, 24; No. 32, a washer 13/16 in. in diameter, ⅛ in. thick, with ¼-in. reamed hole; No. 33, a ¼-in. 24-thd. hex. nut; No. 36, two 3/16-in. 32-thd. adjusting screws, ⅜ in. long, with knurled heads ½ in. in diameter; No. 39 a square head bolt 1 3/16 in. long over all,



How the tool and grinder tables, the table motion lever, and other parts are made

threaded for ½ in. with ¼ in. 20 thds.; No. 43, 2 square head binding screws threaded for 5/16 in. with ¼ in. 20 thds.

It might be added that the bushing on the emery wheel should be .005 larger than the spindle so that the wheel will slide on without cramping and the flanges should be tightened just enough to hold the wheel firmly. For best results the wheel should run up to 2500 r.p.m. A ¼- or ½-hp. motor will provide the necessary power.

Shop Features for October

AN IMPROVED toolpost for the lathe will be described by H. L. Wheeler.

In "Machine Shop 'Kinks' I Have Found Useful," H. W. Bente will write on mechanical shortcuts of wide utility.

Discussing the subject of babbitting, Joe V. Romig will give many time-tested tricks in handling anti-friction metals and in casting both large and small bearings.

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Our big stocks of standard makes of radio sets, parts and supplies enables us to make prompt shipment from stock. Play safe—buy standard equipment from a reliable house. No cut price material.

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The Prophylactic Tooth Brush
Earned its reputation by "mouth to mouth" advertising

Auto Differential Acts as Speed Changer in Factory

HOW an auto differential is put to ingenious use in an industrial plant is illustrated in the accompanying diagram.

The machine carries two reels of wire, the wire being wound from one to the other, and conditions are such that the wire must run slack at all times.

At first a friction cone speed changer was used, but it gave unsatisfactory results.

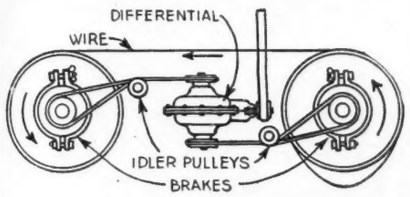


Diagram of a simple method for regulating the speed of one revolving part to suit another

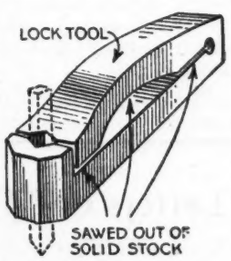
Then an auto differential was clamped to a part of the machine in such a way that two short shafts, replacing the halves of the axle, were held in a vertical position. Each shaft carries a sheaved drive pulley. The drive shaft of the differential is replaced by a short shaft carrying a pulley that is connected by a belt with the line shaft. Each reel carries an adjustable brake.

Both halves of the axle revolve at the same speed as long as the tension is equal. As soon as one side receives a heavier pull, that side revolves slower and the speed of the other side increases.

With slight changes, this arrangement may be used on many machines where the speed of one revolving part must be adjusted automatically in relation to another.—R. H. KASPER, Philadelphia, Pa.

Simplified Lathe Tool Holder

NO CLAMPING screw is needed with a tool holder constructed on the principle of that shown in the accompanying illustration. It is made of a piece of machine steel. The hole for the tool bit is broached at an angle of 10 degrees to the long axis. The central opening is then drilled and filed and the saw cuts made as indicated. The pressure of the tool post depresses the tool holder enough to grip the tool bit firmly.—L. M. B.



Requires no clamping screw

Screwdriver for Tight Places

ONE of the most useful tools in my emergency kit is an offset screwdriver with very short bits, made as shown. It was formed from a straight bar of steel about ¼ in. square, the ends being drawn thinner. A short portion at each end is turned down at right angles to the shank and one end is turned flatwise. The tips are dressed to screwdriver shape.

Useful in repair work

This device will turn screws wherever there is room for swinging a quarter circle or more at the side.—CHARLES A. PEASE, Monrovia, Calif.

Count Your Gains!

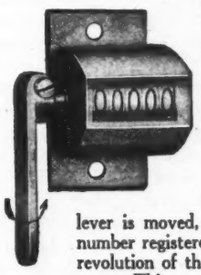
A COUNT of what you are getting—from men or machines—is the first step toward getting *more*. Start out to register *gains*, and you soon have the gains. Veeder Counters will record them.

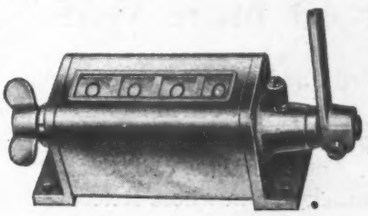
Here are Production Counters, that tell what your machines produce and *ought* to produce. Automatically giving you the records which make for *improvement*—both in developing machines and machine *operators* into better producers.

Hand Talley Counters for counting by the mere pressure of your thumb, anything from packages to people! And Speed Counters for finding revolutions-per-minute of machinery. *EVERY* needed counting device of the finest manufacture, may be found among

Veeder COUNTERS

This Small Rotary Ratchet Counter (No. 6) counts reciprocating movements of the lever, as required for recording the output of many small machines. When the lever is moved through an angle of 40 to 60 degrees, the counter registers one. The further the lever is moved, the higher the number registered. A complete revolution of the lever registers ten. This counter can be adapted to no end of counting purposes, by regulating the throw of the lever. Price, $2.00. (*Cut nearly full size.*) Small *Revolution* Counter of similar model, also $2.00.

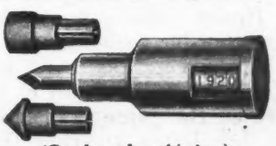




The above Revolution Set-Back Counter records the output of any machine where a shaft-revolution indicates an operation. Sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figure-wheels, as illustrated, $10.00—subject to discount. *Cut less than one-half size.* Set-Back Rotary Ratchet Counter, to record reciprocating movements as on punch presses, $11.50 (list).

Speed Counter

Here's the handiest instrument for finding revolutions-per-minute of a shaft or flywheel. You hold the tip of the counter against end of revolving shaft; press lightly when the second hand of your watch comes to 0; release pressure when minute is up. A spring clutch controls the recording mechanism.



(Cut less than ½ size.)

The Veeder Speed Counter enables you to keep motors, engines, generators, line shafting and machines operating at *efficient speeds*. Price, with two rubber tips (as illustrated) $3.50.

Hand Tally

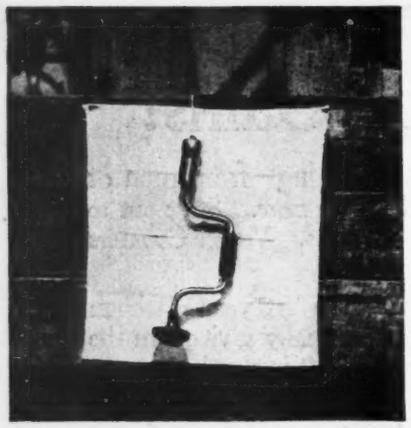
The Hand Tally illustrated below is used for counting anything from number of people attending a ball game, to number of packages in an inventory. In the public place it counts *persons;* in the factory or store it counts *stock;* in the "open" it may count anything from cattle on a ranch, to poles on a telephone line!

Registers one for each pressure of the thumb lever; counts up to 10,000, then repeats. Can be set back to zero from any figure by turning knob once round. Size, exclusive of finger ring, 2 inches greatest diameter. Price, $5.00.

Scores of counters not illustrated here await your looking-over in the new Veeder booklet. Costs you nothing to see them—beyond a letter requesting this 80-page book. Let it go in today's mail.

The Veeder Mfg. Co.

44 Sargeant Street, Hartford, Conn.



August Budde bought this Millers Falls Brace in 1882

He says it's "good for 40 more years"

THE old brace shown here has done good work in its time—and lots of it. We refer you to Mr. August Budde, of Paducah, Kentucky, from whose letter we quote:

> "In 1882, being then a young carpenter, I needed a brace. I went to a local hardware firm, Geo. O. Hart, and told them I wanted a good one. They sold me a small 6" brace made by the Millers Falls Company. I have used this brace constantly in my work since that time, and am using it now. *It is good for forty more years.*"

Millers Falls tools that have seen years of service—and are good for years more—can be found in every city and town in the United States—and in most foreign countries. If you want a brace or a drill or hack saw that will last a lifetime, look for the name "Millers Falls" on the tools you buy.

Every tool so marked is made of fine materials by men who know their business.

MILLERS FALLS COMPANY

Millers Falls, Mass.

Manufacturers of Carpenters' Tools, Hack Saws and Automobile Tools.

MILLERS FALLS TOOLS SINCE 1868

The Most Useful of My Tools—and Why

By Joe V. Romig

EVEN as a mother or father will hesitate in picking out the favorite child, so will a mechanic hesitate in naming his favorite tool. He loves them all, yet one will be usually of greater practical worth than all the others.

My favorite tool is a 50-ft. steel tape line. This I always carry with me in my vest pocket, day and night, weekdays and Sundays. In a ⅜ by 2¾ in. nickel case, it weighs about 5 oz., lies flat in the pocket, is a beauty to look at and a beauty to use.

Both for overall length measurements on short or long work, I prefer it to a foot rule as it can be used in cramped places, between shoulders, and through openings. I measure diameters, as well as circumferences, and find it more reliable than calipers.

Just try taking the measurement of a large diameter by finding the circumference with the tape. The only precaution necessary is to subtract twice the tape's thickness after dividing the actual measurement by 3.1416.

Around my home I find it a most valuable tool. Here is what I have measured: chicken netting, window screening, rugs and carpets, shades and curtains, cistern chain, wash line, fencing, oilcloth, leather belting, shafting, and lumber.

A neighbor one day asked me to lay out his garden in a geometrical design after the style of an old-fashioned flower garden. The center was quickly found with a tape line, and a stick with a nail in the top acted as a pivot for the curves. Flower beds of uniform size and perfectly round are made by looping the eye of the tape line over a nail on a central stick and scribing a line on the ground by means of a stick clamped to the tape line at the desired distance.

I have known a friend of mine who works on the third floor of an office building to whistle to the tobacconist across the street, order his favorite brand of chewing tobacco, and haul it up with a tape line—to save himself going for it. Another neighbor, who was bothered how to draw some new electric wiring through a conduit, used a tape line and the job was quickly done.

Early in the summer I used my tape line on one occasion to lower a cherry bucket from the top of a high tree. This saved many trips to the ground.

While out driving one day with a friend, we were run into by a car driven by a speed maniac who misjudged his half of the road and sideswiped our auto. After the accident he protested that he had been on his side of the road and that it was our fault; that we should have turned out and given him his share.

A crowd had gathered in the meantime and we had plenty of witnesses, so I took out my tape line and measured the total width of the road at the side where the accident occurred. Then I laid off one half of the width at several points and drew a line through that. It was then clearly shown that the offender had been at least 6 in. on our side when he struck us. A sketch was quickly made and all dimensions filled in. Several witnesses signed this, and, when the case came up in court, the jury quickly settled in favor of the tape line evidence that I supplied.

Yes, sir, the tape line is my favorite tool.

Three Prizes Offered for Letters on "The Most Useful of My Tools"

IN THE article above, Mr. Romig tells about the most useful of his tools.

Mr. Romig has many good reasons for the selection of the tape line as the pride of his toolchest. In his letter to the Editor he describes a surprising number of uses for it around his home. But all home workers do not agree. Some prize most highly the saw, others the hammer, others the ax, the plane, the chisel, the file, the screwdriver, and so on.

Now then—which is the most useful of *your* tools? Which one do you use most? Why? And how? Undoubtedly you have some uses for your tools that nobody else has thought of. Tell us about it in a letter of not more than 400 words.

We offer these prizes: $25, first prize; $15, second prize; $5, third prize. The competition closes September 20. The winning letters will appear in the January issue.

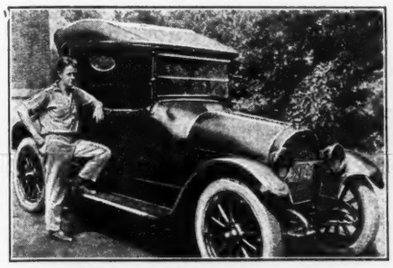
It doesn't matter how you write the letter—typewriter, ink, or pencil; whether you use one side of the sheet or both; or whether you speak from the standpoint of a professional or an amateur mechanic. Each letter will be judged by the Board of Editors solely on the practical worth of its argument, and their decision will be final. No letters will be returned unless accompanied by a self-addressed, stamped envelope.

Address Tool Contest Editor, POPULAR SCIENCE MONTHLY, 225 West 39th St., New York.

Would You Like to Own This Automobile?

SMOOTH running and good looking as this car is, it was about ready for the junkman a few months ago. It was that type of "used" car that can be picked up for less than $100—sometimes a great deal less. If you are of a mechanical turn of mind and know how, you often can remodel such an auto into a thoroughly serviceable machine.

How to do it will be told in a series of articles beginning in the October number of



How the home worker can remodel a car, as this one was rebuilt, will be told in a remarkable series beginning next month

POPULAR SCIENCE MONTHLY. This series was especially written for the Home Workshop by Ray F. Kuns, Principal of the Automotive Trade School, Cincinnati, Ohio, who rebuilt the car illustrated.

Mr. Kuns will tell what to look for in purchasing a used car, how to dismantle it, how to overhaul the frame, the spring assemblies, front axle, steering gear, rear axle, universal, brakes, and transmission; how to dismantle, inspect, and repair the engine and electrical equipment; how to rebuild the units into the car frame, make body and top repairs, paint the auto, and run in the engine.

Blueprints to Aid You in Your Home Workshop

IN PLANNING your fall work, do not overlook POPULAR SCIENCE MONTHLY'S invaluable blueprints, any one of which can be obtained for 25 cents by using the coupon below.

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225 West 39th St., New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have checked below, for which I inclose.....cents in stamps or coin:

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8.	Shaving Cabinet	25c	☐
9.	Arbor with Gate and Seats	25c	☐
10.	Porch Swing	25c	☐
11.	Bench and Tilt-Top Table	25c	☐
12.	Electric Washing Machine	25c	☐
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14.	Toy Train, Horse, and House	25c	☐
15.	Home Workshop Bench	25c	☐
16.	Inlaid Radio Cabinet	25c	☐
17.	Cedar and Mahogany Chest	25c	☐
18.	Telephone Table and Stool	25c	☐
19.	Grandfather's Clock	25c	☐
20.	Flat Top Desk	25c	☐
21.	Colonial Writing Desk	25c	☐
22.	Girl's Cabinet and Desk	25c	☐
23.	Pergola Garage	25c	☐
24.	Gateleg Table	25c	☐
25.	Sailing Outfit for Canoe	25c	☐
26.	Baby's Crib and Play Pen	25c	☐

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A few weeks after you start you can earn good money on the side by doing electrical repair and installation jobs. This gives you a fine start towards an electrical contracting or repair shop business of your own. We will tell you just how to do it when you are ready.

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Louis Derr, S. B., A. M.
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William Esty, S. B., M. A.
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W. H. Freedman, C. E., E. E.
Head, Department of Electrical Engin'ing, University of Vermont

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A. G. Turnbull
Meter Departme't, Commonwealth Edison Company, Chicago.

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"YANKEE" TOOLS

Make Better Mechanics

Building a Supersensitive Radio Set

(Continued from page 76)

be used; a 30-ohm rheostat is necessary. A 22½-volt B battery can be used for the plate circuit but better results will be obtained with the use of a battery of from 45 to 90 volts.

Both the upper and lower sections of the stator should be wound clockwise. The upper terminal of the upper section (1, in the wiring diagram) connects to the resistance R1 across the condenser bank and to the phone terminal 3, while the lower end, 7, of this winding connects to one of the leads from the rotor. This connection is very important, since, if the connections are reversed, the set will not work at its full efficiency. The other end of the rotor winding connects to the plate terminal of the tube socket.

One terminal of the condenser bank resistance, R1, connects to the ground terminal and the other to the tickler coil winding, 1.

The stationary plates of the condenser, 2, connect to one terminal of grid leak, R2, and also to the aerial post. This terminal of the grid leak is then connected to the upper terminal of the bottom stator section, and from there a wire runs to one terminal of the grid condenser. The other terminal of R2 is connected to the other terminal of the grid condenser and from that point a wire goes to the grid terminal of the tube.

Binding post 3 serves for one terminal of the telephones and 4 of the other. Post 4 also serves as the positive terminal of the B battery. Post 5 is the connection for the negative of the B battery and the positive of the A battery; 6 serves for the negative terminal of A battery. The panel used was 7x10.

Operates a Loudspeaker

This set is very sensitive and can be used with any small type of aerial. In some cases, for the reception of local signals, it can be used without an aerial at all. It should never be forgotten, however, that when using any type of set, the results obtained are usually in proportion to the efficiency of the aerial. With an aerial 60 ft. long, local stations were brought in by this set loudly enough to operate an ordinary loudspeaker so that speech could be clearly understood over a fair sized room.

It is important in wiring the set to make sure that no long leads are used. While short, direct leads, crossing and crisscrossing, do not look as well as long ones running parallel to each other, they give better results and greater freedom from noises caused by the inductive feedback between different parts of the circuit.

Bus bar wiring, either bare or covered with "spaghetti" tubing can be used, but for all general purposes, No. 18 annunciator or bell wire, which is cheap and easy to work with, will give good results.

If the set is used with an ordinary aerial, the tuning is not very critical and is done by varying the wave-length adjustments and regulating the regeneration. When these adjustments have been made, further adjustments of the values of the grid leak resistance and the other resistance across the condenser bank will help bring the signals to full intensity.

If the set is used with a loop aerial, one end of the loop should be connected to the aerial post and the other end connected to the ground post. Another method is to connect one end of the loop to the aerial and a regular ground to the ground post. When used without an aerial, the ground wire should be connected to the aerial post.

Where these comparatively inefficient types of aerials are used, the set becomes very critical in tuning and great care and patience are required to get good results. In such cases a distinct whistle, which varies in pitch and intensity as the adjustments are made, will be heard in the receivers. This is a characteristic whistle present in superregenerative receivers.

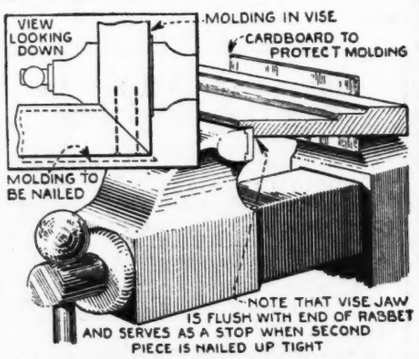
If the tone of the whistle is low and prominent, it can be decreased in strength and increased in pitch by increasing the resistance of the resistance elements. If it is too high, it can be lowered by decreasing the resistance. When the set is properly adjusted a high pitch whistle is present but it is not very noticeable and does not interfere seriously with reception.

Picture Frames Easily Nailed in Machinist's Vise

THE simplest fixture for making picture frames is an ordinary machinist's vise.

After the molding for the frame has been cut in a miter box to the right lengths, one piece is placed in the vise, as shown. The front jaw fits into the glass rabbet and one corner of the jaw is placed exactly flush with the end of the rabbet. The outside edge of the molding is protected with a strip of cardboard or wood from being damaged by the other jaw of the vise.

The piece to be nailed is held against the mitered edge of the molding in the vise with


VIEW LOOKING DOWN
MOLDING IN VISE
CARDBOARD TO PROTECT MOLDING
MOLDING TO BE NAILED
NOTE THAT VISE JAW IS FLUSH WITH END OF RABBET AND SERVES AS A STOP WHEN SECOND PIECE IS NAILED UP TIGHT

How picture molding is held in a machinist's vise for gluing and nailing a frame together

the sharp corner projecting back a trifle, as indicated by the dotted lines in the small diagram. This is because nailing tends to draw in the joint. Holes for the nails are then drilled through one piece and a short distance into the other with an automatic hand drill or other tool.

Both mitered edges are thinly covered with hot cabinetmaker's glue, and the joint is nailed. It is automatically lined up because the front jaw of the vise acts as a stop.

When two pieces are joined, the other pair are put together, and then both pairs are nailed in precisely the same way. Care should be taken not to use too much glue, and if any accidentally gets on the face of the molding, it should be removed immediately with warm water.

This little trick of using a machinist's vise is invaluable when frames have to be made in the home workshop.—A. L. C.

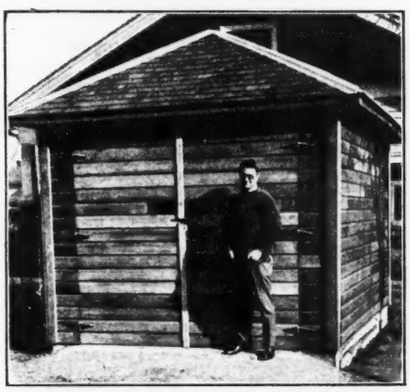
How I Built a Small Garage for $78

By C. E. Rogers

DURING the first seven months I owned my Ford, I rented four different garages. Then I decided to put up my own garage, and within a month I drove my car into it.

The garage cost me only $78.15, but that was due to my doing practically all the work myself. My knowledge of building is no more, however, than that of the average business or professional man.

A friend who once carried a carpenter's union card helped me to plan and start the construction, and I hired a high school student for a short time to help me. Most of the heavy work, from mixing and pouring



Finished except for painting, this 10 by 14 ft. garage was built in a month's spare time

concrete for the foundation to putting on the shingles and doors, I did myself.

After examining a number of small garages in the neighborhood, my friend and I decided upon one 14 ft. long, 10 ft. wide and 8 ft. high. We planned a concrete foundation and a floor made with the winter's supply of cinders. A hip roof was chosen to suit the architectural design of my dwelling.

Here is the complete bill of materials I bought:

4 2 by 4 in., 14 ft. long, for wall plate
6 2 by 4 in., 10 ft. long, for wall plate
35 2 by 4 in., 8 ft. long, for uprights and rafters
52 1 by 6 in., 10 ft. long, drop siding
50 1 by 6 in., 6 ft. long, drop siding
18 1 by 6 in., 8 ft. long, drop siding for doors
4 1 by 6 in., 2 ft. long, sheathing for door frames
6 hinges and 1 hasp and staple for doors
7 bundles shingles
22 1 by 6 in., 16 ft. long, sheathing
12 1 by 4 in., 8 ft. long, for trim and fascia
2 1 by 4 in., 14 ft. long, for fascia
½ keg eightpenny nails
1 lb. spikes
2 lbs. sixpenny nails
4 lbs. shingle nails
40 ft. ridge roll
5 bags cement
1 wagon load of sand

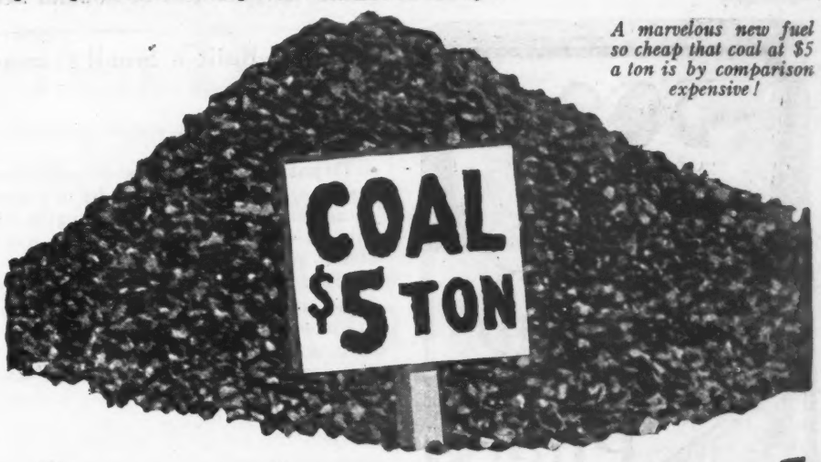
The lumber was grade No. 2 for such sizes as the dealer handled that grade.

We first made forms for a 6-in. thick foundation. The mixture of sand and cement was not as rich as builders use for larger structures; we guessed it roughly as about 1 part cement to 10 or 12 of sand. While the mixture was green, we inserted two bolts in the foundation on each side for anchoring the sill. There was enough concrete left for the entrance run.

The framework for the two sides was constructed flat on the ground, and then raised in place, adjusted and plumbed. Uprights were placed at intervals of 3½ ft.

The hip roof was our hardest problem. The timbers were fitted individually and then sawed, for neither my student assistant nor I knew how to "read a rule." It was

(Turn to page 94)



A marvelous new fuel so cheap that coal at $5 a ton is by comparison expensive!

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Now that this remarkable gas has been achieved, no home anywhere has to put up with the drudgery and expense of coal for fuel. No matter how old your stove, or what make, so long as it will burn coal or wood, it can be quickly adapted to Oxo-Gas with no alterations in the stove.

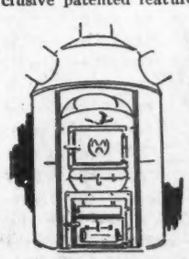
Heating with Oxo-Gas beats heating with coal and costs a lot less

The New-Day Fuel for Cooking and Heating

The only ingredients you have to buy for the making of Oxo-Gas is kerosene—common everyday coal oil, as easily procurable as sugar at any corner grocery, at a few cents a gallon. A unique invention, a simple device called the Oxo-Gas Heating appliance fixed in your stove in a few minutes, takes the kerosene and vaporizing it, mixes it with oxygen (4% kerosene and 96% oxygen) and makes Oxo-Gas, the cheapest fuel ever made for man, and as the Oxo-Gas device burns it, the most efficient fuel ever made for man.

The Oxo-Gas device is not to be confused with the various oil-burning devices with which the market is flooded. It differs in principle, in design, in construction, in performance.

It is a device that really makes a gas, and burns this gas as a gas—as cleanly apd silently as any city gas stove, but much more efficiently in the heat created. The burners of the Oxo-Gas are lava discs—an exclusive patented feature. These discs are rendered semi-incandescent under the heat of the gas. This intensifies the heat by refraction from 20% to 30%, which gives you a hotter fire than coal, wood or city gas—a fire that cooks quicker and one you can instantly turn off when through, when you want a cool kitchen.



Make your furnace an Oxo-Gas Burner. Save work and coal money, enjoy greater comfort

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Even if Oxo-Gas did cost more than coal, it would still pay to use it instead of coal. With Oxo-Gas you have heat when wanted and as long as wanted. Heat you can *regulate* to perfection for any and all cooking and baking—heat you can regulate to suit the weather, heat for every purpose, with no coal scuttle drudgery and no smoke, soot or ashes. But as a matter of fact, instead of costing as much, Oxo-Gas is so cheap as to be practically incomparable with the cost of coal. Just think—one gallon of kerosene will make enough Oxo-Gas to heat a range or heating stove eight to ten hours. The average cost of kerosene being from 8 to 12 cents a gallon, the cost of cooking or heating with Oxo-Gas is but 1¼ to 2 cents an hour. *2 cents worth of gas to cook a meal.*

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"Red Devil" Pliers give long time service and satisfaction—drop forged of steel—will last for years.

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shown above, the most useful tool of its kind for the home, workshop or car. The handles fit the hand without pinching—the thin nose reaches hard-to-get-at places—the slip joint widens the range of objects that can be gripped.

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"Red Devil" Glass Cutters—the glaziers' standard tools of the world. "It's all in the wheel." Made in 40 styles. No. 024 shown here, 20c.

How I Built a Small Garage

(Continued from page 93)

a tedious way to do it, but we obtained good results.

To put on the siding and shingles was an easy job. If possible, a builder of a similar garage should buy siding in lengths to fit without unnecessary sawing, but I was unable to get the right lengths.

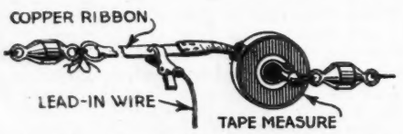
The doors were of the simplest variety or "made in," that is, siding in 8-ft. lengths was nailed to the door frames, just as if the opening were to be closed permanently. The doors were then completed by sawing through the middle of the siding and swinging each half on hinges.

When the garage is painted it will be quite presentable, and as useful as a much more expensive one.

Unique Portable Aerial

EVERY owner of a portable radio set would appreciate an aerial that winds up without kinking into a space no larger than a pocket steel tape.

To make such an aerial is not difficult. Obtain 100 ft. or more of copper ribbon about ½ in. wide from a dealer in brass and copper or any large electrical supply house. Then get a pocket tape line holding 100 ft. of cotton tape; an old or secondhand one will do. Pull the tape out and cut it off about 6 in. from the very end. Fasten one end of the copper ribbon to this short length of tape line with two small paper fasteners.



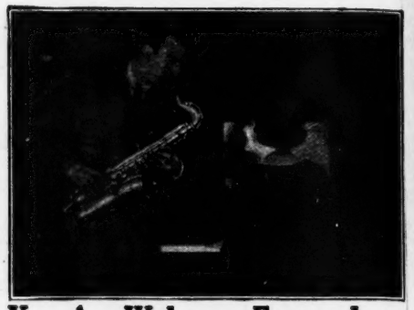
A cheap cotton tape measure is converted into a reel for 100 ft. of aerial ribbon

Then reel up the aerial and fasten the small ring from the end of the tape line onto the end of the ribbon.

Two small insulators and some cord are also necessary. Then, when you wish to put up the aerial, tie an insulator to the end of the ribbon and fasten it to a tree or post. Unreel the aerial, fasten the other insulator to the crank and tie it to any handy support. For a lead-in use a simple lampcord with a battery clip soldered at each end. —JOHN A. MAHON.

Oilcan Serves as Automatic Reservoir for Poultry Pen

A FIVE-GALLON oilcan that does not leak may be used as a reservoir for the drinking water pan in poultry yards or hen-houses. A hole is punched in the screw cap and the can is filled with water. It is then turned upside down and placed on a wooden block in such a way that the cap is over the drinking pan and a trifle below the top of the pan. When the pan is filled to the level of the cap, the water in it prevents air from entering the reservoir and stops the flow of water. As the pan is emptied, more air enters and in this way the pan is automatically kept filled as long as there is water in the reservoir.—E. R. SMITH, Walla Walla, Wash.



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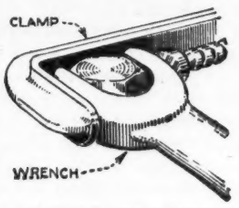
Reinforcing an Open Wrench with a Clamp

WHEN it is necessary to use an open end wrench for unusually heavy work, the jaws can be protected from spreading and possibly breaking by means of a steel clamp placed across them, as shown. This was done recently in the case of a tank cap that had become corroded and was exceptionally hard to remove. It was necessary to use a long pipe extension to obtain sufficient leverage to turn the wrench, but no harm was done to the wrench jaws because of the reinforcing effect of the clamp.—M. P. V.

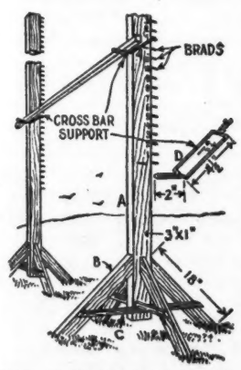


A clamp strengthens the wrench jaws

High Jumping Standards

THE uprights, *A*, of these high jumping or vaulting standards are straight pieces of 1 by 3 in. lumber. For jumping standards the height is usually 6 or 7 ft.; for vaulting, about 13 ft. The supports, *B*, also 1 by 3 in., are nailed to the uprights and braced by the pieces *C*.

Brads 1¼ in. long are driven into one edge of each upright at intervals of 1 in., as indicated, and are allowed to project ½ in. to support the cross bar support, *D*. This is made of heavy wire, bent as indicated to support the 1-in. square cross bar.



The jumping bar is quickly raised or lowered

To raise or lower the wire supports, they are simply lifted up and pushed back until the wire loop clears the end of the brads sufficiently to move freely.—HUGH CARD, Lexington, Ky.

Broom Hanger Made from a Wire Ceiling Hook

NEEDING a broomhanger not long ago, I tried in several stores to buy one, but without any luck. I found, however, that it would be a simple matter to make a substitute from an ordinary wire ceiling hook such as is to be found in almost any clothes closet. By bending this as shown, I made a broom hanger that is doing the work as well as any that could be bought in the stores. —W. W. PARKER, Lead, S. D.

A Slow Setting Plaster

HOME workers sometimes will find useful the painters' and plasterers' trick of mixing dry plaster of Paris with vinegar instead of water to make it retain its workable qualities for a longer time. It is then similar to putty and does not set so quickly.—M. C. E.

Ten Days

Bring surprises when you combat the film Make this test

Here is a test which will be a revelation to you. It has brought to millions the glistening teeth you see everywhere today.

Ask for it and watch the results. They will amaze and delight you.

Why teeth discolor

That viscous film you feel on teeth is what hides their luster. Much of it clings and stays. Soon it becomes discolored, then it forms dingy coats which brushing does not effectively remove.

Film also holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay. Germs breed by millions in it. They, with tartar, are the chief cause of pyorrhea. Few escape these film-caused troubles under old-way methods.

Dental science has found two ways to effectively fight that film. One acts to disintegrate the film at all stages of formation. One removes it without harmful scouring.

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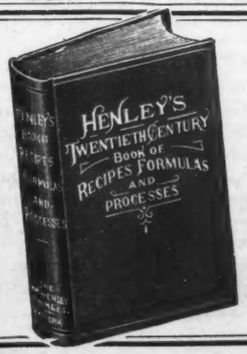

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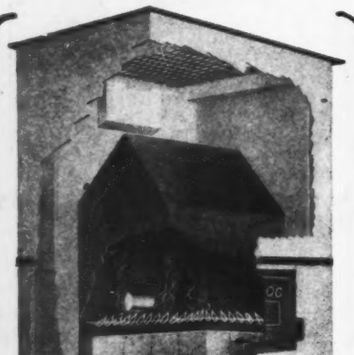

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The Science of Fire Fighting

(*Continued from page 37*)

Street, New York, an excellent fireproof building, caught fire from an explosion of potassium stored there. One incident of the extinguishing of this fire was unique in the experience of the oldest fireman present. After a tremendous quantity of water had been poured into the building, its great walls began to bulge like a giant football under the pressure of an air pump. There seemed no explanation of this phenomenon, for there had been no explosion after the one that started the fire, and the firemen were certain the walls were not collapsing because their supports had been burned away. At last the walls cracked, hurling great chunks of masonry and a huge flood of water into the streets.

Scientific investigation brought the explanation of this weird happening. The bulging and bursting of the walls was caused by the swelling of great rolls of newsprint paper as they absorbed the water.

Ammonia Fumes Are Dangerous

A most dangerous fire from a fireman's standpoint is one occurring in a large meat market or a large restaurant where ammonia is employed in the refrigerating apparatus. In the past, many firemen have been overcome and some have died from ammonia fumes when fighting fires of this kind. Science, however, has furnished them with protection. It has perfected the gas mask, and it has brought about laws compelling persons using ammonia for refrigeration to equip the freezing apparatus with pipes which, in case of fire, carry the deadly fumes beyond the roof of the burning building.

Nitric acid, employed in a great number of industries, also gives off fumes under heat which may cause death when inhaled. This is even more dangerous than ammonia, because it is odorless and consequently cannot be detected by the fire-fighter before he has absorbed enough of it to cause unconsciousness. Chlorine gas, which the fireman frequently encounters in fires in bleaching establishments, is likewise poisonous. Chlorate of potash, commonly used for sore throats, becomes highly dangerous under heat, for it will explode and also give forth a poisonous gas.

Some chemicals present serious problems for the fire-fighter because when they burn they cannot be extinguished by water. Unslaked lime, for example, burns all the more fiercely under a light spray of water, but may be extinguished by being completely drenched. Yellow phosphorus has a similar action under water. In oil fires water is quite useless, only causing the fire to spread, since the burning oil rises to the top of the water and floats away. Fires of this sort must be smothered by sand, flour, earth, or some similar material. Substances which foam readily, such as a certain residue of licorice manufacture also have been used to smother oil fires.

The destruction of the city of Smyrna by fire a few months ago offers a striking contrast between the inefficient fire-fighting methods of the past and present day scientific fire protection in the United States. A photograph of one of the engines used in attempting to cope with the Smyrna conflagration is shown on page 36. The photograph gives a vivid explanation of why Smyrna was reduced to ruins. Yet it was not so many years ago that apparatus almost as crude was used by the firemen of the greatest cities in America. There are plenty of people who recall the picturesque days of the volunteer departments, with their "manuals"—hand drawn engines—hand pumps, red shirts, trumpets and one-section ladders.

In those days, and even later, it was the custom to close all doors and windows in a burning building, the theory being that the fire would be cut off from oxygen and would burn itself out. No fault can be found with that theory, but the trouble is that it is impossible to seal a building hermetically. There always will be leakage of air sufficient to feed the fire when the building is closed. A more serious objection is that a closed building offers no escape for smoke, and consequently makes it impossible for firemen to enter to fight the fire.

The present-day method, especially when a fire has started in the lower part of a building, is to open the roof and also to make an opening at the bottom. This forms a sort of chimney, which, while it causes the fire to burn more fiercely for a time, also permits the firemen to get at it and put it out. In the Fire College in New York City we have two miniature buildings in which we demonstrate this principle. All modern theaters now have roof scuttles above the stage which open automatically.

In the Williamsburg section of Brooklyn, where rows of old fashioned wooden tenement houses are common, this method of clearing the atmosphere within a burning building has been employed recently. Previously several of these rows had been destroyed, chiefly because they all had concealed attics extending the whole length of a row, through which the fire spread invisibly after it seemed to be under control. Then firemen in that part of the city, started to fight these fires by opening up the roofs and ground floors at three places—at the ends and at the places where the fires had started.

The modern fire-fighter is ever resourceful and ever ready to expose himself to any danger, if there is a chance of saving lives.

Firemen Trained in College

The New York Fire Department operates a Fire College which is a college in fact as well as in name. Scientific fire-fighting from every aspect is taught by officers of the department and by professors from the scientific departments of leading colleges and universities. Among the subjects taught are general fire fighting, use of apparatus and tools, engines and boilers, high pressure systems, marine fires, high tension electric currents, combustibles and explosives, gasoline and motors, fire alarm telegraph, auxiliary fire apparatus, first aid to the injured, discipline and administration.

By theoretical study of these subjects and practical drills the department is grounded in the scientific principles of modern fire fighting. Likewise in equipment the modern fireman utilizes the latest scientific discoveries. Water towers that permit a hose line to be raised 10 stories above the street, efficient alarm systems, and motor-driven apparatus—these are only a few of the aids which science has given the fireman.

But, although he utilizes the latest scientific equipment, the professional fireman prefers to prevent fires rather than to extinguish them.

Will the Sun Ever Fail Us?

(*Continued from page 41*)

has revealed that virtually every chemical element known on earth is present in the sun. In fact, some elements have been discovered in the sun before it was possible to isolate them on earth. A striking example of this is helium, which was observed in the sun 30 years before its presence on earth was known. Coronium, a gas which occurs in the corona of the sun, has not yet been found on earth.

In the brilliant photosphere are observed dark areas known as sunspots. What they are, no one knows. They have been described variously as cavities in the sun's surface and as giant whirlpools. From them arise great whirling streams of glowing gases and around their edges circle tongues of flame. The number of sunspots varies, but varies definitely. A period of about 11 years covers the development of the number from a minimum to a maximum and the diminution to a minimum again. To astronomers this carries an important message—since the spots are periodic in appearance they must necessarily have some deep-seated connection with the fundamental facts of the sun's structure and activities. The study of sunspots also has shown the astronomer that all parts of the sun's surface do not appear to rotate at the same speed, from which fact he has drawn his conclusion that the center of the sun cannot be a solid body.

Sunspots Produce Storms on Earth

Just at present the daily photographs made from the U. S. Naval Observatory, show that the sun is passing through what astronomers call the minimum sunspot period—a matter of vast interest to the earth, since sunspots have been shown to produce, in a mysterious way, magnetic storms that cause great havoc on the earth.

Recently Father Ricard, director of the astronomical and mathematical department of the University of Santa Clara, Santa Clara, Calif., declared that electrical waves emanating from sunspots were responsible for *all* storms on the earth and the other planets. These waves, he said, break up cloud formations in the atmospheres of the planets, causing precipitation of the moisture they contain in the form of rain.

Astronomical instruments show enormous flames of red glowing gases shooting outward from the sun's surface for thousands of miles. Is this fire? Astronomers say no, not in the sense, anyway, in which we know fire on earth. Fire to us implies combustion, burning; and scientists say the sun is not burning. There is no sign of any wasting or diminishing in the sun's composition. Instead, after supplying light and heat to its universe for probably millions of years, the sun is going on as ever before, and has even increased its power, some astronomers say, since the beginning.

Even should the lessening in the sun's energy noted by Dr. Abbot continue at a regular rate, scientists say that it would take centuries and centuries before the sun would cool off to an extent that would prove harmful to the earth. And in the meantime, they assert, the inhabitants of the earth would have adjusted themselves to the gradually changing conditions.

We may look upon the energy of the sun, then, no matter what its source, as inexhaustible.

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The Proofs of Evolution

(*Continued from page 28*)

just as modern cats do to make themselves seem larger and more formidable to an enemy.

That is the origin of our gland-caused gooseflesh. The glands of those catlike ancestors of ours learned that one of the things they had to do in getting ready for a fight was to raise the hair. Our glands do it still. Many modern animals, the cats among them, ruffle up their hair in the same way, not by any effort of the will, but by a chemical discharged from their adrenal glands into the blood, the same chemical, in fact, that our glands produce and discharge.

Embryology Supports Theory

The fourth proof of evolution is the proof from human development, from what is called the science of embryology. Each human being begins as a single fertilized egg cell less than a hundredth of an inch in diameter. This cell divides into two. Each of these daughter cells then divides again into two, these new cells divide in turn, and so on until the millions of cells of the full grown human body are produced.

These growing cells in the beginning show not the slightest resemblance to the human form. They look, at first, just like the little one-celled creatures with which we believe life began a billion or more years ago.

Later on, when there are a hundred or two cells in the developing human embryo, the whole of it looks like some of the sea-dwelling, wormlike creatures that also belonged, we believe, in the line of human ancestry. After a few more days of development, the embryo looks like a young fish, later like a young reptile, still later like a young calf or pig, and so on. Each human being in his development before birth goes through stages in body form, in skeleton, and in all internal organs that recall unmistakably the stages of our animal ancestry that we read from fossils in the rocks.

Baby's Heart Resembles Fish's

When the first signs of a heart begin to appear in the tiny unborn child, the organ is merely a straight tube open at both ends, as the heart still is in the lancelet, a lowly wormlike ancestor of the fishes. A little later the developing human heart has two chambers as the hearts of fishes have. Still later it has three chambers like the hearts of reptiles. Only when the embryo is well on toward birth does its heart acquire the full complement of four chambers characteristic of man and of the other mammals.

At one stage of its prenatal history the human embryo has slits in the sides of its neck corresponding to the gills of fishes. At a later stage it has an external movable tail like the tails of cats or monkeys. Indeed, all human beings still possess, buried in the flesh of the back, the bones of this tail. You can see them in any human skeleton or you can see your own in an X-ray photograph.

The first kidney of the growing embryo is in its neck, where the kidney still is in worms. Later the duties of this first neck kidney are taken over by a structure like the kidney of frogs and other amphibians. Still later the true kidney develops and both the earlier ones disappear.

Other animals show a similar suggestion by the growing embryo of some of the stages in the history of its race. The six-day chick, growing inside the egg, has a five-fingered hand instead of a wing, just as its reptilian ancestors had. The unhatched parrot has teeth as had the ancient fossil birds. The blind fishes that live in caves have eyes when they are very young, showing that they are descended from seeing forms. The sea-squirt, a vegetable-like animal that lives on the sea bottom, is born as a swimming fishlike creature that later settles down and degenerates, just as the race of sea-squirts has done in the geologic past.

Every known fact about the development of unborn animals, as of unborn human beings, fits perfectly into the evolutionary picture. The facts do not fit into any other picture. How can we explain, for example, the fact that the human embryo makes use in turn of three separate kinds of kidneys, unless we admit that these are survivals, bodily memories, of the history of the kidney in the past?

The fifth proof of evolution is the proof by experiment. Evolution has been produced artificially.

This is denied sometimes by the opponents of the evolution theory. It is asserted that no new kind of creature, no new species ever has been created, demonstrably, under the eyes of man. This is simply not true. Many species have been so created, some of them by plant and animal breeders, others by scientists in the laboratory.

Plants Furnish More Proofs

What is the famous spineless cactus but a new species? Or the edible apple as contrasted with the wild one, or the domesticated milk-giving cow, or any one of the thousand kinds of man-bred dogs? Every domestic animal and nearly every cultivated plant is sufficiently different from its wild ancestor to be called a different species. Out of the wild "love apple" of the Indians, man has produced at least a dozen varieties of tomato, most of which would have been set down as different species if they had happened to be found wild.

This fifth proof does not prove, of course, the evolution of *man*, for man has not been made artificially. But it proves the truth of evolution as a whole, while the other four proofs show that man belongs with the rest of animal creation. If evolution applies to any animal, it applies also to man. The fact, too, that there are so many different kinds of living men suggests that man himself has been altering and diverging even in the comparatively recent past. Man is a domestic animal, for all that he domesticated himself; and he has altered, apparently, under domestication, just as cows and dogs and horses have done.

Was Man Hairy All Over?

Consider, for example, the effect of clothing on the body hair. Apes are hairy all over and so, presumably, was primitive man. Hair was a protection from cold and rain. Modern men have lost most of this body hair and they have lost it most completely from their backs, shoulders, and abdomen, from just those parts of the body, that is, which were best protected by the first form of clothing, the animal skin flung over the shoulders and tied together in front. The parts of the body that were left

exposed, the chest, legs, forearms, and the top of the head, are just the parts where man still has some hair.

Even on these parts the hair is going rapidly, as men grow accustomed to more and thicker clothes. The use of hats is having its inevitable effect. The increasing commonness of baldness is a sign of evolution going on right under our eyes or, rather, in an anatomical sense, right over them. A bald man who opposes the truth of evolution does so against the testimony of his own head.

These, then, are the assembled proofs of evolution. First, the proof from the fossils. Second, the proof from vestige organs, such as the appendix. Third, the proof from ancient body habits, for instance the hair-raising action of the adrenal glands. Fourth, the proof from the development of the unborn child. Fifth, the proof from the creation of new kinds of plants and animals by man.

To state these proofs is not, of course, to make them convincing to everybody. Conviction will come to the determined skeptic only, I think, from firsthand contact with the evidence. He must see and handle the fossils. He must study the structures of the human body in the dissecting room or in detailed anatomical models, and he must compare these structures with the corresponding ones of animals. He must examine the unborn human embryo at various stages of its growth, something that he can do in any good medical museum. He must work with living plants or animals and must see for himself how he can alter them by breeding and selection.

If he will do this—if any one will do this—I am content to leave the decision to his own intelligence.

¶ Next month—The Story of the Plants—How they manufacture sustenance from the sun, air and water to feed man and the animals.

FOR FURTHER READING

THE best recent summary of the proofs of evolution is "Evolution and Christian Faith," by H. H. Lane (Princeton University Press, Princeton, N. J., 1923). A much briefer book of similar scope is, "I Believe in God and Evolution," by Dr. W. W. Keen (J. B. Lippincott Co., Philadelphia, 1923). More detailed discussions will be found in "Organic Evolution," by Lull, referred to in the third chapter of this serial, and in the first two volumes of the four-volume "Outline of Science," edited by J. Arthur Thomson (G. P. Putnam's Sons, New York, 1922). "The System of Animate Nature," by J. Arthur Thomson (Henry Holt and Co., New York, 1920), is also good.

On the specific evidences for the animal origin of man, see "Man," by Sir Arthur Keith (Home University Library, Henry Holt and Co., New York, 1912), and "Man—the Animal," by W. M. Smallwood (Macmillan Co., New York, 1922).

The serious student must not neglect the classics of evolution—"The Origin of Species" and "The Descent of Man," by Darwin; "Man's Place in Nature," by Huxley, and "Island Life," by Alfred Russell Wallace. All have been issued in many editions.

"Toughening" Plaster of Paris

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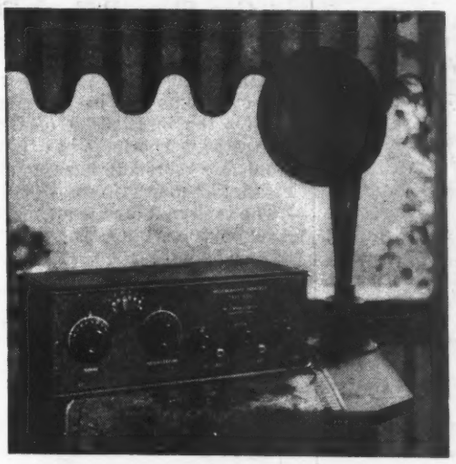

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32x3½	6.50	1.50	34x4½	9.15	2.50
31x4	7.00	1.60	35x4½	9.25	2.60
32x4	7.50	1.85	36x4½	9.45	2.70
33x4	7.85	2.15	35x5	9.75	2.80
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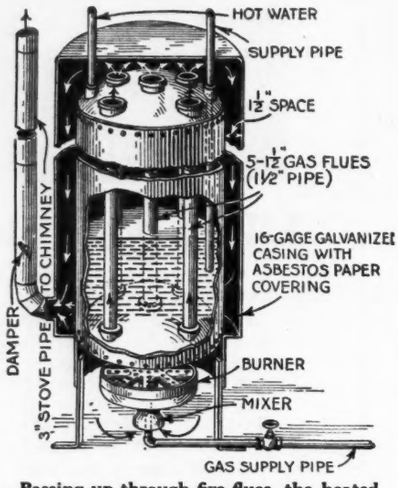
Gas Flues Reduce Cost of Heating Water in Home

GAS consumption for water heating in one home has been reduced materially by the installation of the pipe flues illustrated. The tank has been in use for about five years and has repaid the cost of installation many times.

The tank and burner arrangement is of a common type, but I installed five 1½-in.



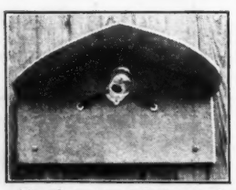
Passing up through five flues, the heated air then circulates down and around the outside of the water tank

pipes in the tank and arranged a sheet steel casing around it, so that the hot gases, after passing up through the pipes, are forced around outside the tank to the bottom, where they escape through a 3-in. stovepipe to the chimney.—F. C.

Quickly Made Electric Yard Light

AT A cost of not more than $1 each for materials, it is possible to provide good yard lights for the farm or small town property.

The supporting board is ⅞ by 12 by 18 in. cypress, cut as shown. A 10 by 24 in. sheet of galvanized sheet steel or iron is bent in an inverted V shape and nailed to the upper edges of the board to form a hood.



Hood protects lamp and reflects light downwards

A light porcelain receptacle is screwed to the board in the center, and, 5 in. from the top point and 5 or 6 in. at each side of the center, holes ⅝ in. in diameter are bored for the insertion of two porcelain insulating tubes. Two ¼-in. holes are bored 2 in. inside the lower corners and another near the upper point to take 2½-in. lag screws. The light should be placed about 15 ft. high.

If the wiring is to come from inside the building, fasten the board in place after removing the insulating bushings and then bore two holes through the building wall in line with the holes in the board and pass the tubes through both board and wall. If the wiring is to be entirely on the outside of the building, no insulation tubes are required and two knob insulators should be used in their place.

The board and hood should be painted with white bicycle enamel or aluminum paint.—J. R. KUNTZ.

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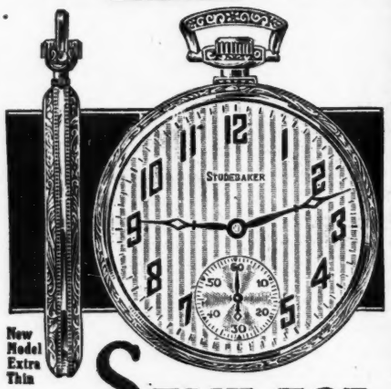

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Pipe Frame Supports Workbench

Pipe Frame Supports Workbench

(*Continued from page 78*)

in. oak; the other boards are 1¼-in. pine. The boards are fastened to the pipe supports with U-bolts and make a solid bench top.

The grinder may be turned to face the end of the bench, but the arrangement shown is preferable because the belt does not interfere with feeding long rods through the lathe spindle.

With an outfit such as this, the amateur will have little difficulty in handling a large variety of work. The few suggestions that follow may, however, smooth over some of the problems that are apt to perplex any worker who has not had much shop experience.

As most lathes are provided with index plates to give the sizes of gears necessary for thread cutting, the only figuring the amateur usually has to do is for special threads. A method used by many practical men is to express the required lead as a fraction and multiply the numerator or divide the denominator by the number that represents the lead of the lead screw. If you wish to cut 27 threads in 5 in., the fraction will be 5/27, which, multiplied by 5 (representing the lead screw), gives 25/27, the proportion of the gears.

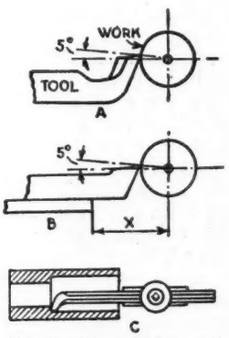

Fig. 2. How turning and boring tools should be mounted

I have assumed that the spindle and stud of the lathe are evenly geared; otherwise the actual lead of the screw is disregarded and in its place is used the number of threads an inch the lathe would cut with even gears on stud and screw.

In cutting threads, care must be taken that the cutting edge is at the exact center of the work.

Perhaps the hardest part of the amateur's work is to keep his tools in proper shape. At the outset he should buy a center gage that also serves for grinding screw cutting tools and setting them at exact right angles to the mounted work.

To do good work a lathe tool must be mounted properly. A position 5 degrees above the center of work to be turned, as shown at A, Fig. 2, is the approved practice. In setting the cutting edge of a boring tool, however, reverse this rule and place it about 5 degrees below the center (Fig. 2, C). As with outside tools, great care must be taken to see that the boring tool is securely supported to prevent any downward spring.

Tools Must Be Well Supported

A chattering tool is caused, as a rule, by the cutting edge being too great a distance from the support. At B, Fig. 2, attention is called to distance X, which in all cases is to be kept as short as possible. It is also important to remember that the turning tool must be kept at right angles to the center line of the work or the work will have a tendency to turn either large or small.

As much amateur work is done in brass, a word or two regarding the rake of a tool may be helpful. There are two rakes used,

(*Turn to page 102*)

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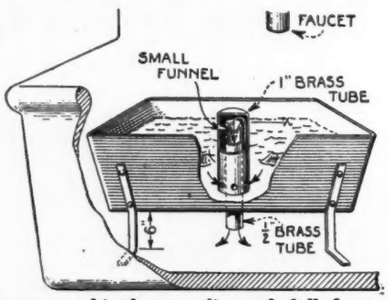
Automatic Photo Print Washer Changes and Agitates Water

ALTHOUGH I have tested nearly all the photographic print washers placed on the market during the last five years, none has given the satisfaction of the one illustrated. This is built on the principle of the Tantalus cup of the ancient Romans.

When the water level rises to the height marked X, it enters the downflow tube and almost all the water in the tray is then siphoned out with a rush. By regulating the flow of water from the faucet, the washer will operate every two minutes.

Another advantage is that the hypo-laden water at or near the bottom is removed first. The prints are also agitated during each water discharge, so that at the end of 15 minutes they are absolutely free of hypo.



As soon as this photo tray is nearly full of water, it is emptied automatically from the bottom

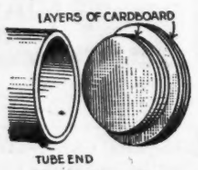
The inner tube is ½-in. and the outer tube 1-in. brass. The inner tube has a small funnel-shaped piece soldered inside the top. The outer tube is capped with a piece of brass soldered airtight. About ½ in. from the bottom of this tube a series of ¼-in. holes is drilled to allow the water to flow into it from all directions.

The washer illustrated is made from a large tinned dishpan, but the principle is the same with any kind of container. The only requirements are that the inner tube must have a discharge length of from 2 to 6 in. below the bottom of the vessel.

If a tin cup or basin filled with water is placed under the washer so that the siphon tube dips into it for about 1 in., the down rush of the water is increased still more.—JOHN H. SCHALEK, Pittsburgh, Pa.

Making Radio Tube Ends

END pieces for tubes on which homemade radio coils are to be wound can be made satisfactorily with no materials other than hard cardboard and some liquid glue.



For radio coils

Suppose the tube is 3 in. outside diameter and 1/16 in. thick. Cut several 2⅞-in. disks to make a pile a little more than ½ in. thick, and an equal number of disks 3¼ in. in diameter. Coat the disks evenly and thinly with glue, string them together, using their center holes as a guide, and put them under a heavy weight to dry for at least 24 hours.

When the glue is dry, clean off any surplus, smooth the edges of the disks with fine sandpaper, and finish with two or three coats of flat paint or enamel. End pieces made in this way are surprisingly strong and can be drilled and even tapped for machine screws.—H. G.

Pipe Frame Supports Workbench

(*Continued from page 101*)

a positive and a negative rake. The cutting edge of the positive rake slopes away from the work and is used in cutting steel and other hard metals, while the cutting edge of the negative rake slopes toward the work. If a tool with a positive rake is used for turning brass, it will "bite in."

A side rake of 14 degrees (see Fig. 3) is generally used for medium hard steel, but 10 to 12 degrees is better for harder stock. The back rake of 8 degrees is constant for all materials.

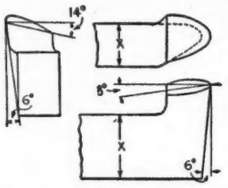


Fig. 3. Typical turning tools, showing side and back rake

A full set of lathe tools is something that very few mechanics possess, but it is advisable to use the right tool for the right job if good work is to be done.

Lathe tools are forged from either tool or crucible steel and can be tempered by heating slowly and evenly for a distance of about 2 in. from the cutting point. After heating to a cherry red the required distance, the tool is dipped in cold water to a depth of only 1½ in. After the point has cooled, it is removed from the water and carefully cleaned with carborundum cloth and wiped clean with a piece of waste or cloth. The heat in the shank of the tool will drive the temper toward the cutting edge and when the edge becomes a brown straw color, the tool is immersed in water.

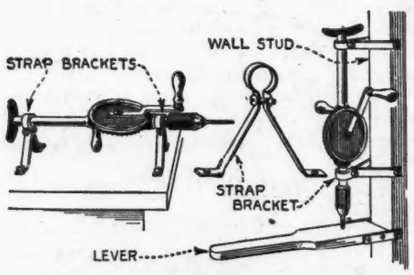
A word of caution in regard to the use of tools: Keep them sharp. Do not run them to destruction before regrinding. Do not overheat when hardening. Do not heat too rapidly.

In grinding drills, use a gage that gives the angle of the point. If you are in a hurry to drill, increase the feed rather than the speed of your drill.

Breast Drill Mounted on Bench Does Light Turning

TURNING taper pins, filing down bolts, truing valves and similar small repairing jobs, as well as coil winding, can often be done with a breast drill, if other means are lacking.

One way to mount a drill for this sort of work is to use two small strap brackets bolted to the bench as shown. The same brackets also serve for attaching the drill to a wall stud or post for use in heavy dri ling.



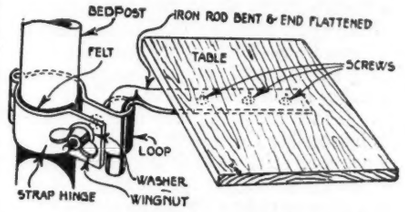
Two easily made brackets support the drill for winding coils, light turning, or heavy drilling

A hinged worktable with a lever handle can be made along the lines indicated for use when drilling. This is a handy arrangement for drilling holes through shafts and bolts for cotter pins.—S. L. K.

Small Adjustable Table Attaches to Bedpost

A STRONG rack or table for the sick-room that can be attached to the bedpost and swung around to various positions, as well as raised and lowered, can be made with little difficulty, as shown.

A strap hinge is bent to go around the bedpost and the point of one leaf of the



The table raises, lowers, and swings

hinge is then formed into a loop to take the table rod. A hole is bored for a bolt and wingnut to clamp the leaves of the hinge around the post.

By heating and hammering the rod, it is bent to the shape indicated and one end is flattened and drilled for the screws used in attaching it to the board. A convenient size for the table is 12 by 12 in., and it can be made of ½, ⅝, or ⅞-in. stock.

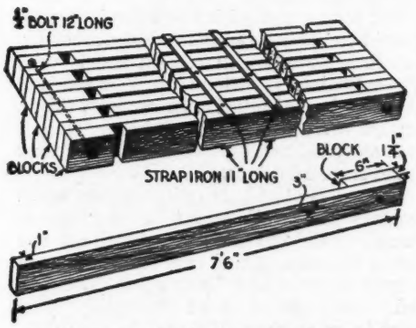
Felt is glued to the inside of the hinge to prevent the metal from scratching the bedpost.—W. E. KING.

Adjustable "Plank" Saves Time in Painting and Paper Hanging

TO AID me in my paperhanging and painting business, I use a staging plank that is adjustable in length. The one plank serves all purposes because it can be compressed to suit a small room or pulled out for a large room. It is inexpensive and can be made by any one.

Ten boards 1 in. thick, 3 in. wide, and 7 ft. 6 in. long, and 10 blocks 1¼ in. thick, 3 in. wide, and 6 in. long are required, as well as two ½-in. bolts 12 in. long, four pieces of strap iron 11 in. long, six 3½-in. bolts, and a small can of glue.

Take five of the 6-in. blocks and five of the 7 ft. 6 in. boards, and put them together as shown, first gluing them and then bolting them up with large washers at each end. Make another similar section and fit the two together, bolting on the



This decorator's plank can be shortened or lengthened to suit any ordinary room

strap irons 6 in. from the center of the whole plank so that they are 1 ft. apart. A bolt can be run through the two center boards near their inside ends to serve as stops to prevent the "plank" from coming apart when opened in a hurry.

The complete staging plank is safe, convenient, and a genuine time saver.—LOY E. OWEN, College View, Neb.

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Science Says Use Nu-Gas To Cook and Heat

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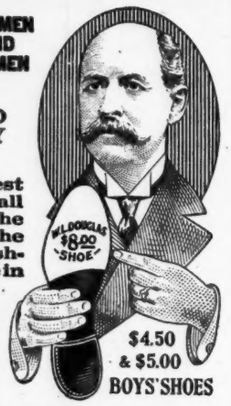

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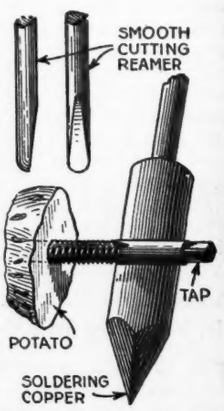
Home Workshop "Kinks" that Will Save You Time

THE breakage of small drills, which is a constant annoyance to amateur mechanics, can be reduced greatly by breaking the drills short in advance. The smaller sizes of drills are too long for general use in a hand drill, but broken in two they are stiff enough to stand up quite well. This dodge saves drills without number. For drilling in lathe or drill-press the full length can be used with only ordinary care.

Using small taps is even more provoking than using small drills because when they break off in a hole it is difficult and sometimes impossible to remove them. When a tap begins to stick it is usually because of the chips clogging. To prevent this, back it out a turn or two and then go ahead until it sticks again, repeating the process. If the hole is deep, this alone probably will not suffice and the tap will have to be backed all the way.



How to make a reamer and draw temper partly from a tap

As a tap does practically all its cutting at the end and with the first few full threads, not much is gained by having the rest of the threaded part very hard and brittle.

As an experiment, the writer drew the temper of several small taps, leaving full hardness where the real work was done. This was accomplished by sticking the point of the tap into a cut potato far enough to cover the point and half-a-dozen full threads. After brightening the flutes with fine emery cloth, a hot soldering copper was applied to the shank. The color began to change and run down toward the point, and, when the color close to the point had become a rather dark brown, the tap was plunged quickly into cold water. The potato prevented the end from losing its temper. After much use these taps are still intact. Drawing the temper must, however, be done carefully or you will find that the tap is spoiled by over-softening.

Working tool steel in the lathe is usually thought a hard proposition for the amateur, but it is not difficult if drill rod is used where the job is not too big. This rod is of high grade tool steel and comes in 3-ft. lengths perfectly straight and truly round. It is annealed and easy to work. The sizes range from 1/16 in. up.

From this steel it is quite easy to make reamers to smooth and true small holes. Round off the end of a piece of drill rod the size of the hole, taking care that the curve is truly circular, and file or grind down the end at an angle of about 10 degrees. One point is important: If a section should be made across the reamer just where the rounded end starts, it should show an exact semicircle; at that point the breadth of the flat should equal the diameter.

Harden and temper the point to a light straw color. Drill the hole a shade under size and run the reamer through. If the tool is made properly, the bore will be dead smooth, polished and true. This "kink" seems to be almost unknown among amateurs.—HOWARD GREENE.

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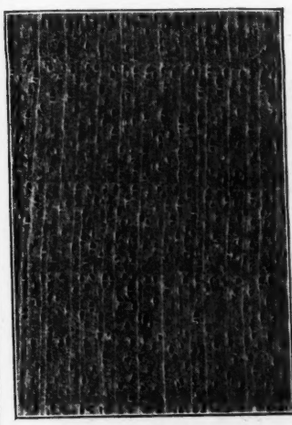
Identifying Walnut and Mahogany

(*Continued from page 77*)

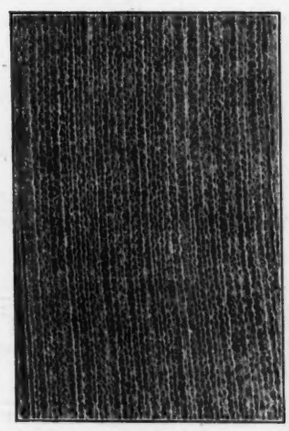
men of burl walnut, used often for ornamental overlays and inlays on fine furniture. Compare it with the stump walnut figure directly below. Even experienced furniture dealers often describe a stump figure as burl walnut. One is obtained by slicing up huge burls or knots that grow as excrescences on some walnut trees; the other comes from near the base of the tree where the wood is beautifully rippled, usually for not more than a foot or two above the ground.

Walnut cut somewhat cross-grained so that the pores appear as short dashes

The crotch veneer, of which a particularly striking specimen is shown, comes from just below the juncture of two large limbs of a tree. The sliced wood specimen is from the southwest, probably Texas, and has a distinct contrast of light and dark. It is an interesting panel because it shows almost perfectly the picture of a hound's face.



Microphotograph, magnified 7½ times, of the end grain of yellow birch, which often is used as a substitute for walnut or mahogany. The pores hardly can be seen without a lens and are far too small to be mistaken for those of the more expensive woods



The end grain of red gum magnified 7½ times. This is another wood that can be finished to look very much like walnut or mahogany, but its pores are even finer than those of birch. They cannot be seen without a glass

Microphotographs furnished by Forest Products Laboratory, United States Forest Service

Four characteristic mahogany veneers shown on page 77 are—crotch, raindrop, fiddleback, and striped. The names are sufficiently descriptive in each case to indicate the kind of figure.

There are several other figures often encountered, notably the well known rotary

(*Turn to page 106*)

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Identifying Walnut and Mahogany

(*Continued from page 105*)

cut figure, which is obtained by cutting a log around and around. The striped figure is obtained by splitting a log into four parts lengthwise and slicing a flat side of each quarter.

Matched veneers, so often mentioned by cabinetmakers, are obtained by reversing and matching two pieces from the same log or stump. In this way magnificent patterns are obtained, sometimes like a branching tree or like a conventionalized human or animal figure.

Hints on Choosing Furniture

Even in the best furniture construction, it should be noted that the hidden or less conspicuous parts are made of relatively inferior boards or veneers and that the choicest figures are reserved for the more important parts. Solid walnut or mahogany furniture is sometimes made, but it is exceedingly expensive. Solid construction is necessary for elaborately carved furniture, but where plain panels predominate, veneered stock is usually preferred, since the choice of fine figures is greater and the grain can be "matched" more easily.

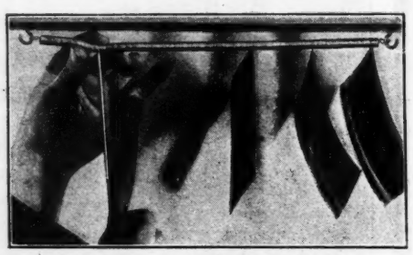
When a dealer says that a piece is walnut or mahogany throughout he usually means that it is made entirely of the one wood, some parts being solid and some veneered.

Whenever "combination" is mentioned in connection with walnut or mahogany furniture, it means that while the larger panels and conspicuous parts are genuine, the frame or posts are made of a substitute wood and finished to match. Also, when a piece is described as walnut or mahogany "finish," it is frankly a substitute. The use of these two terms is often criticized as being misleading, but they are nevertheless in general use.

By following the suggestions given above, any one can decide for himself with reasonable accuracy whether or not a given piece of furniture is genuine walnut or mahogany.

Spring Holds Drying Films

BY USING a spring as shown, a photographer can dispense with the numerous spring clip holders ordinarily needed in the dark room. One spring holds a number of



Bending the spring to insert a film

negatives and there is no danger of the films being scratched.

To insert a film the spring is bent at one point with the fingers, as indicated, a corner of the film inserted and the spring released.—J. B. FLOWERS, Gloucester, N. J.

Old Brush Useful for Staining

KEEP a wall brush that has been worn to a chisel edge for applying stains. For covering large surfaces, such as trims or partitions, use a brush 4 in. wide.

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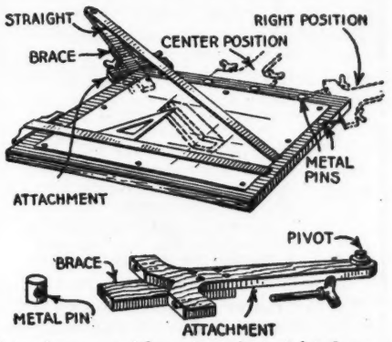


Extension arm with a pivoted straightedge provides the means for drawing "vanishing" lines quickly and accurately

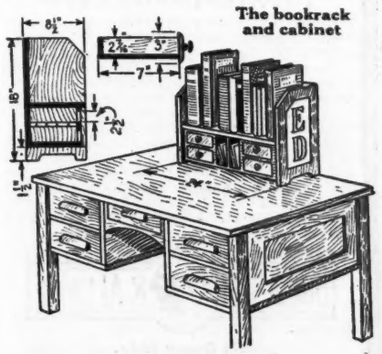
plies right-, left-hand and, if necessary, "over" vanishing points.

The attachment consists of an extension that can be bolted, as shown, to two corners or the upper edge of the board. The thumbscrews fit tapped holes in metal pins inserted permanently in the board.

At the end of the extension is a pin that serves for pivoting a long, thin, straightedge. A small brace under the arm helps support the weight.—F. C. W.

Making a Bookrack Cabinet

A COMBINATION bookrack and cabinet with small drawers and pigeonholes often is a desirable addition to a flat top desk or a table used as a desk. The design shown is particularly simple to con-



The bookrack and cabinet

struct and the shape of the ends and the dimensions can be changed to suit the requirements and taste of the builder.

The ends and bookshelf are oak, dressed on both sides to a ¾-in. thickness, and the bottom and back are ½-in. whitewood. The drawer fronts are of oak, and the whole is finished to match the desk.—J. V.

Non-Tipping Ink Bottle

USED on the tilting surface of an adjustable drawing board or artist's table, the holder illustrated keeps the ink bottle level. It is made of two strips of light sheet metal about ¾ by 5 in., and two short strands of malleable wire.—JOHN M. PIPP, Muncie, Ind.

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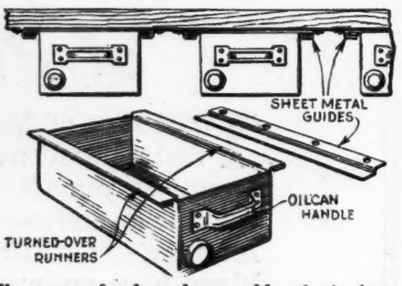


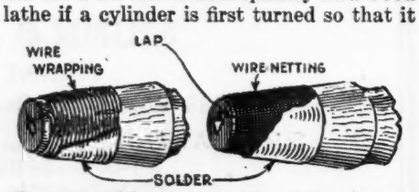
The runners for these cheap and handy tin drawers are made by cutting and bending the ends of the cans

each end is doubled over and bent, as shown, to form runners. These runners are engaged by guides of sheet metal fastened to the under side of the bench, shelf, or other support.—M. P. J.

How to Make Ferrules

IN THE home workshop it is sometimes necessary to make ferrules. Often they can be found ready made; for example, the brass caps on the ends of the carbon rods in a much used variety of dry cell serves well for light use. Small flanged unions, such as are used for gas lines on autos and on supply pipes for wash basins, make substantial and ornamental ferrules. For most purposes ferrules of brass or copper pipe are quite satisfactory, and short lengths and scraps can be obtained from plumbing shops and garages for next to nothing. The tubing in old chandeliers also is useful.

To cut the ferrules the right length is a simple matter if a machine lathe is at hand, but the work can be done quickly on a wood lathe if a cylinder is first turned so that it



Two ways of forming strong tapered ferrules

will slip inside the pipe and a file is ground to serve as a tool. In the latter case, leave the work for a short time on a steam pipe or near a stove so that the ferrule will expand enough to be removed easily from the wooden core.

When a cone-shaped or other odd shaped ferrule is required, wrap No. 22 or 24 copper or soft brass wire around the end, as shown, beginning at the small end so that each turn will crowd the one before. After fastening the end, give the whole a coat of solder. This produces a strong ferrule, does not take as long as one would think, and always fits. Tinned iron wire can be used but is not as good.

Cone-shaped ferrules also can be made from copper or brass gauze. Cut the gauze to fit with snips, allowing a lap of 1/8 or 3/16 in. Recess the wood under the lap to improve the appearance and hold the gauze in place with a couple of tacks after it has been rapped or rubbed into shape with a hammer. A coat of solder is then applied. —EDGAR A. STANTON, Seattle, Wash.

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Smoking the

How to Lay Out and Drill Your Radio Panel

By D. H. Palmeter

THE smooth mechanical working and the neat appearance of a panel-mounted receiving set, depend to a considerable extent upon the accurate laying out and drilling of the radio panel.

A well spaced panel with cleanly drilled holes is a delight to the eye. One with holes poorly alined and disfigured by burrs and uneven countersinking is always a sign of amateur workmanship.

As in nearly all home workshop undertakings, a good drawing is the first essential. Note whether the drawing represents the front or back of the panel. If you make the layout yourself, draw it full size as viewed from the rear of the panel. That is because a panel should be laid out from the back. If the drawing you are working on shows the front of the panel, remember that holes located from the left edge will be located from the right edge when you are laying them out on the panel itself and vice versa.

Composition panels, already cut out to a number of standard sizes, can be obtained.

Laying out a radio panel with accuracy is easy when the right system is followed

Get one of the right size and lay its polished side down on two thicknesses of clean wrapping paper placed on a smooth, level bench or table.

The location of each hole is indicated by the intersection of two straight lines or by a single line and an arc of a circle. You will need the following implements: a square, either a try-square, draftsman's T-square, or a combination machinist's square with graduated blade; a pair of machinist's dividers; a scriber or a phonograph needle held in a refillable pencil, and a center-punch. If the square has no scale marked on it, a rule also will be required.

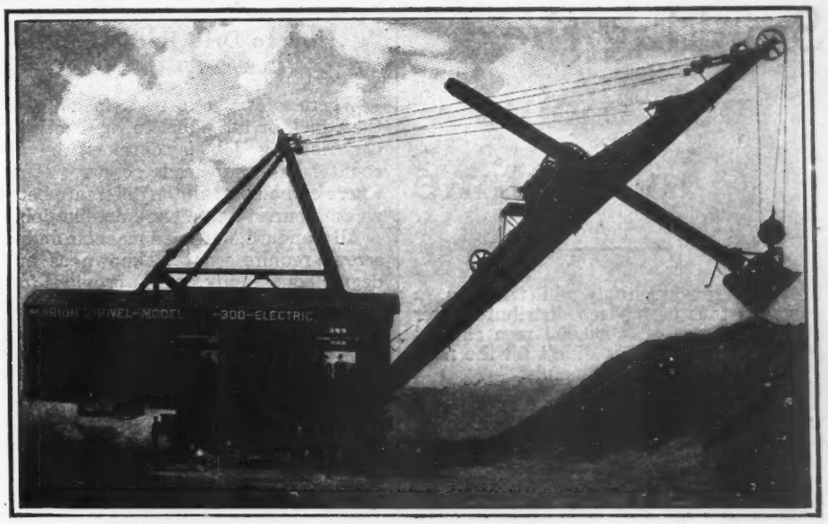
Locating the Holes

A study of Fig. 1, which shows a typical panel layout, indicates where the holes are located. When these are on the same horizontal or vertical line, one hole is laid out by measuring from two edges of the panel, as at A and B; the dividers are set for the distance between the holes, and the arcs are struck, as at C, D, E, F, G, H, and I. Holes located on the circumference of a circle are "stepped" with the dividers.

Next the intersections are marked with a centerpunch and drilled with a No. 42 drill.

Turn the panel face up and mark with lead pencil all the holes that require the smallest size drill. Drill these first. Then mark and drill the next larger size, and so on. In this way you will not make the mistake of accidentally drilling a ¼-in. hole where a ⅛-in. hole should be.

(*Turn to page 110*)



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A giant worker—excavating over three hundred thousand cubic feet a day! In three days, six hours and thirty-six minutes, it could handle material equal in cubic contents to the Washington Monument.

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General Electric Company makes many different types of motors, some small enough to wind a clock, some large enough to operate these giant shovels; but *all* designed to help electricity do more for human service at a lower cost.

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31x4	2.15	.90	35x6½	4.25	1.65
32x4	2.20	1.40	36x6½	4.25	1.65
33x4	2.25	1.40	33x7	4.25	1.65
34x4	2.25	1.40	34x7	4.25	1.65
35x4	2.25	1.40	35x7	4.25	1.65

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Smoking the peace pipe in wartime

As any ex-doughboy will tell you, a thousand tons of tobacco distributed over a fighting force of 2,000,000 men showed good intentions, but it didn't fill the need —not by a few million pipefuls.

Even today letters still come in from veterans who have forgotten the horrors of war and remember only the thrill of "a real American smoke" in France.

For one, Hugh Livingstone, Adjutant of Yankee Division Post, No. 272, V. F. W., remembers:

Providence, R. I.

Larus & Brother Co.,
Richmond, Va.

Gentlemen:

My introduction to Edgeworth took place over in the training area in France under circumstances that left a lasting impression of the good qualities of Edgeworth.

One night, after a hard day's work, my bunkie drew a package from home, one of those mysterious affairs that might contain everything but what you wanted.

After due ceremonies of guessing he opened it and the first thing we saw was the blue box of Edgeworth. All further operations ceased until we filled the pipes. After using the French *tabac* for several weeks and burning our mouths and throats to a raw state you can imagine how cool and satisfying that Edgeworth tasted to us.

We smoked until we were ordered to bed, and I fell asleep smoking. You can just bet a letter went home for more Edgeworth.

Since that time I have used about every kind of tobacco that is put up, but it is Edgeworth for me when I can get it. Thank you for putting such a satisfying and cool tobacco on the market.

Gratefully yours,
(Signed) Hugh Livingstone.

Probably any good American smoking tobacco would have brought the same joy to Mr. Livingstone and his bunkie in France. But it is a fact that when Edgeworth makes a friend, more often than not it is a lifetime affair.

Edgeworth's one great asset for most smokers is that it is always the same. You can buy a package in Chicago, another in New Orleans, another in San Francisco, and each package will give you the same cool, satisfying smoke.

If you are not an Edgeworth smoker, you are cordially invited to accept some free samples of both Edgeworth Plug slice and Ready-Rubbed.

Just drop a post card with your name and address to Larus & Brother Company, 59 South 21st Street, Richmond, Va., and the free samples will be forwarded to you immediately. If you will also include the name and address of your tobacco dealer, your courtesy will be appreciated.

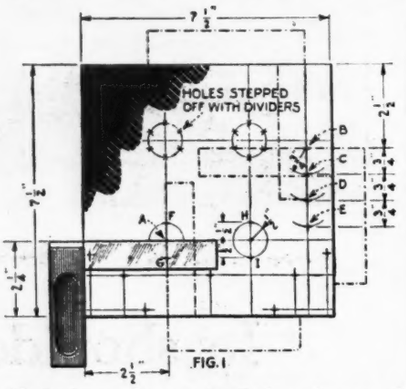
To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug Slice or Ready-Rubbed for the same price you would pay the jobber.

How to Drill Radio Panels

(*Continued from page 109*)

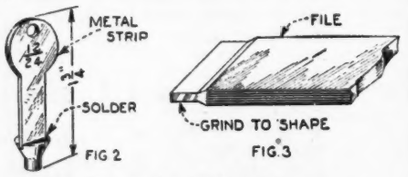
Where screws are used to fasten parts to the panel, or the panel to the cabinet, the best looking job is obtained by using countersunk flat-head screws. Here is where care makes all the difference between an amateurish and a workmanlike job.

All standard, flat-head machine and wood screws require what is known as an 82-degree countersink. This provides for the correct angle, but it is equally important to countersink all the holes to the proper depth. To do this, one of the screws may be tried from time to time while countersinking until the head of the screw has its top surface just a trifle below the surface of the panel.



All the layout lines are scribed on the rear of the panel, using square and dividers

If much countersinking is to be done, a handy gage can be made, as shown in Fig. 2, by soldering a metal strip to the head of a screw that has been cut off short. The size of the screw may be stamped on the handle.



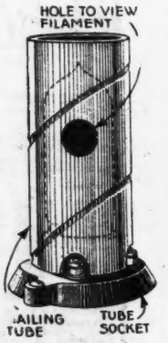
Gage for countersinking and a scraper

If a countersink becomes dull, it can be touched up with an oilstone or a carborundum stone. A dull countersink will throw up a heavy burr and occasionally a new countersink that is very sharp will "chatter" and cut a rough hole. This is easily remedied by backing off each cutting edge slightly with an oilstone.

If burrs are formed, they may be removed with a tool made from an old file as as shown in Fig. 3.

Protector for Vacuum Tubes

MANY a vacuum tube has been broken because a pair of pliers or a screwdriver has been dropped upon it accidentally. Such mishaps can be prevented by protecting the tube, as shown, with a section of cardboard mailing tube. Notches are cut in the lower edge if necessary, to clear the socket binding posts. It is especially advisable to protect the tubes on board-mounted sets in this way.—L. R.



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31x4	2.75	.90	35x4½	4.25	1.65
32x4	3.00	1.40	36x4½	4.25	1.65
33x4	3.25	1.40	35x5	4.25	1.95
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Insulin—A Science Miracle

Concealed Aerial Is Sewn inside Automobile Top

A COMPACT and inconspicuous method of arranging an aerial on an automobile is to sew the wire in a loop inside the top of the car.

The necessary length of insulated wire, say 80 or 100 ft. of No. 20 single or double cotton covered wire, is sewn in an orderly arrangement to a strip of black or brown cambric chosen to match the color inside the top of the car. The rectangular loop is then sewn to the top.

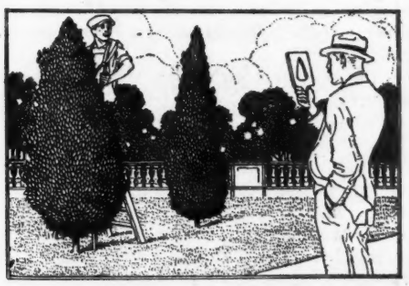
Aerial is completely hidden

In the case of a closed car, the loop may be concealed completely by covering it with fabric of the same texture as the covering. In an open car the loop will fold, when necessary, with the top.

Two installations made in this way have given most satisfactory results, and a more inconspicuous arrangement could hardly be desired.—P. O. R.

Trimming Ornamental Trees

TO TRIM ornamental trees quickly and uniformly is not easy, even for an experienced gardener. An amateur can do it well, however, if he uses a templet of metal, wood or cardboard, made as shown. The shape desired for the tree is first drawn to



small scale on a piece of material no larger than a hand-glass and then cut out.

One man looks at the tree to be trimmed through the templet from a distance equal to the height of the tree or farther and gives directions to another man who does the actual trimming. When the outline coincides with the opening in the trimming gage, the men move around a trifle and in this way quickly make the shape entirely symmetrical. Any number of trees can thus be trimmed exactly alike.—L. C. M.

Clamps for Clothespins

RUGS, blankets and stiff articles of clothing cannot easily be hung on a line with ordinary clothespins so they are often merely thrown over the line. Much better than that method is to hang them with cheap iron clamps, which can be obtained in any five and ten cent store. If the rug or other article is fine, use blocks or strips of wood on each side to distribute the pressure of the clamps, as shown.—N. G. NEAR.

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"If anyone would ask me what kind of bicycle tires I would recommend, I would say, "Vitalics by a long shot." Those tires are real tires. My set of Vitalics will be 5 years old this Sept., and they are not worn out yet." Yours truly Proctor Disbro 17920 Canterbury Road Cleveland, Ohio.

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Big Bicycle makers like Excelsior, Iver Johnson and others put nothing except Vitalic tires on their finest wheels.

"Tougher than Elephant Hide" is a slogan that describes Vitalic qualities exactly.

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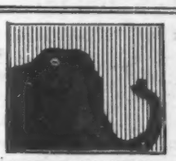

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R. J. Cunningham Inc.

Home Office: 248 First Street San Francisco, Calif.

Eastern Representative: 154 West Lake Street Chicago, Illinois

Insulin—A Science Miracle

(*Continued from page 24*)

nationalities, the Irish and the Jews show an especial susceptibility, and the death rate from the disease consequently is large in states where these two stocks make up a large portion of the population. Estimates as to the number of diabetics in this country vary between 500,000 and 2,000,000.

Despite the undoubted success of insulin, the medical profession has issued a warning that it is not to be regarded as a magic or instant cure. In fact, it is not a "cure" at all, since it does not destroy the causes of the disease. It is a remedy, merely supplying to the body an element that disease has removed. Injections of insulin every day for long periods are necessary to successful treatment. Stopping the treatment, it is said, causes the disease to reappear.

A high degree of skill is necessary in the administration of insulin. The quantity to be injected varies according to the proportion of sugar in the patient's blood, and an overdose of insulin, medical authorities say, may result in serious complications.

Meanwhile Doctor Banting, lifted suddenly from obscurity to worldwide fame, remains, so his intimates say, the same unassuming, serious-minded, diffident young man he was when he returned from the war, wounded and wearing the Military Cross, to begin his professional life in Toronto. The people of Alliston, Ont., where live his father and mother, each past the three-score-and-ten mark, and his brothers and sisters, take immense pride in the fact that he has become the town's most noted son. He still speaks of Alliston as "home."

Began Life as a Farm Boy

Before leaving Alliston 12 years ago to enter the University of Toronto, Doctor Banting was a farm boy, performing chores around his father's homestead like hundreds of other boys in the agricultural sections of Canada. His teachers say that he made no particular mark in his studies, although he was studious and persevering. Up to the time he left there to study medicine, most of the people in Alliston believed he intended to enter the ministry. Immediately after graduating from medical school, he entered the Canadian army, becoming a battalion physician with the rank of captain. He was wounded at Cambrai and invalided to England, where he remained until 1920.

Referring to this incident of his career in the army, his mother recently furnished an illuminating sidelight on his character.

"He made a promise that he would write to me every Sunday when he went away to college," she recalled. "He never has failed to keep that promise. When his right arm was useless from wounds, he learned to write with his left hand so that I'd continue to get my letters."

The Canadian Government recently granted Doctor Banting an annuity of $7500 for life in recognition of his discovery of insulin, and the Ontario Legislature has appropriated $10,000 a year to create a department of research in the University of Toronto. This will be known as the Banting-Best Chair of Research, and Doctor Banting has been appointed its first incumbent at a salary of $6000 a year.

Today the eyes of the scientific world are turned toward Canada, eager to glimpse the new activities of the young physician who has become a world figure at an age at which most professional men are struggling for a foothold.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

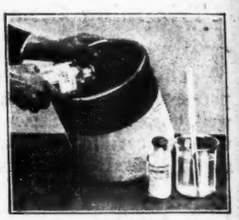
HOW often have you asked: What is the best stain for this particular job? What is the best cement for this difficult joint? What will fill this crack? What will bleach out this spot?

These and scores of similar questions constantly arise in every home workshop. Often they are not answered satisfactorily. The home worker may have the best of tools, but the chances are that he doesn't keep on hand even the simplest chemicals and has no idea what can be accomplished by home workshop chemistry.

The following is the first of a series of articles on this subject.—The Editor.

EVERY homeworker should have certain chemicals always at hand in his workshop. If properly selected, these chemicals will serve many useful purposes.

At times nothing more than filler for cracks may be required; at others the repairing of a leaking crock, jar or washtub may require instant attention; or, perhaps, the splitting or cracking of certain work on hand may require a special type of glue difficult to obtain but easy to make, if the few raw materials necessary are available.



Mending a cracked crock

To make a list of chemicals is, however, quite difficult, because each worker is interested in his own particular problems and a hard and fast assortment may not suit all needs. It is advisable to have on hand the more common solvents, not only for the removal of stains but also for the making of varnishes, glues and the like, together with a few other often used chemicals. A good list is as follows:

Acetone	Alcohol	Rosin
Turpentine, both spirits and ozonized	Ammonia	Precipitated chalk
Acetic acid	Copal resin	White lead
Shellac (orange)	Gum tragacanth	Benzol
Gum arabic	Carpenters' glue	Glycerin
Red lead	Ether	Gelatin
	Linseed oil	Celluloid chips
	Muriatic acid	Waterglass
	Calcium chlorid	

Usually one or two ounces of each chemical is sufficient. If, on occasion, large quantities are necessary, there is always time to obtain them. It is always best to buy special chemicals only when it is known that they are to be used.

An incident showing how useful a few chemicals can be, occurred recently in my own home. A stone crock cracked just before I was going to use it. It was impossible to obtain another of the same size for the experiments I was carrying out and it simply had to be repaired at once.

Waterglass was smeared over the crack and allowed to penetrate. Then a little calcium chlorid dissolved in water was poured in. This made a covering of calcium silicate over the crack and the crock could then be used.

How to make the best use of the chemicals listed above will be told in following articles.—ERNEST BADE, Ph.D.

Warren Radio Loop, Cut Away to Show Construction.

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An Aerial Adjustable to Station

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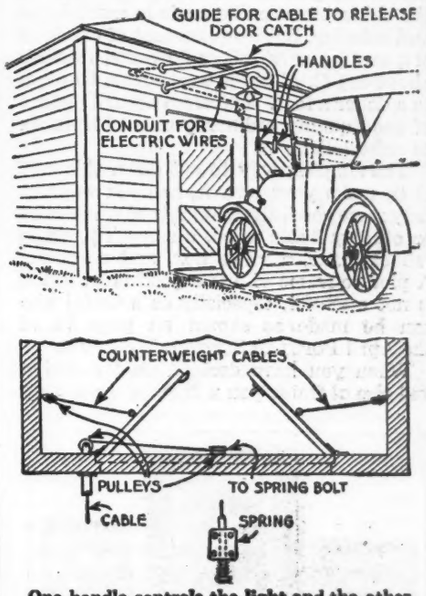
Garage Door Release Combined with Lamp Bracket

TWO added conveniences for the average garage are a lamp in front of the doors and an extension device of some kind by which the doors can be released and opened without leaving the car.

Both of these can be obtained at once by a fixture made as shown. A bracket that



One handle controls the light and the other releases the door catch

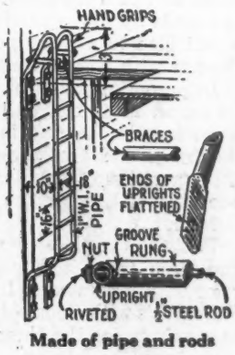
extends 5 ft. is fastened at the left side of and above the door. It is made of two pipes, one of which serves as a waterproof housing for the electric light wire. The other contains a pull cable attached to the door catch.

When approaching the garage, the driver pulls one handle to turn on the light and then the other to release the door.

The installation shown makes use of counterweights to open the doors, as they swing in; with outward-swinging doors, the hinges must be set slightly out of plumb so that the doors open automatically when the catch is released.—P. F. T.

A Permanent Loft Ladder

WHILE the majority of loft ladders in barns, shops and storage buildings are wooden, a stronger and more durable type of metal ladder is usually worth the moderate additional cost in making the installation.



Made of pipe and rods

The ladder illustrated, which is one used in a barn on a Virginia farm, illustrates a cheap and durable form of construction. The uprights are 1-in. wrought iron pipe, bent as shown, and attached to the studding with lag screws. The rungs and upper braces are pipe of the same size, notched at the ends and attached with ½-in. steel rods and nuts. The upper end of the ladder projects 3 ft. above the loft floor to form a substantial handhold.—L. M. C.

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Attractive Picture Frames Cost Little

By E. E. Scott

THE cost of frames and not the value of the pictures is often what makes it necessary for art stores to charge nearly prohibitive prices for the kind of pictures we all should like to have in our homes. The process of lithographing has become so perfected that reproductions of the old masters can be made in exact detail and coloring, but a square foot of excellent art, costing only 25 or 50 cents, requires about 4½ ft. of frame worth from 50 cents to a dollar a foot. Therefore a small picture of good quality ordinarily sells at from six to eight dollars.

The simplest way to cut down this cost is to make your own frames. It requires only some good, straight grained whitewood or other suitable wood, a smooth plane, a rabbet plane, a miter box, and a square. A picture frame vise is a good help, but it is not essential, especially as a useful vise can be made as shown on page 78 of the April POPULAR SCIENCE MONTHLY.

When you have decided on the design and size of frame you will make, square up

Inexpensive reproductions of the old masters are set off to excellent advantage in these plain, easily made frames

your strips with the smooth plane and cut a notch or rabbet for the glass with the rabbet plane. If a wooden rabbet plane is used, a strip can be nailed on the side to form a guiding fence. If a rabbet plane is not available, the notch can be cut with chisels or even a jacknife, or done at a carpenter's shop on the saw-table.

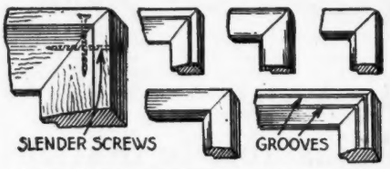
The front face of the strip is then treated in any of the ways shown or in whatever combination of bevels, rounds, grooves, and rabbets that suggest themselves as being most appropriate. Be particularly careful in planing bevels, as a slight variation may ruin the stock. The thin grooves are made by first scratching the strip with a nail filed to a sharp point, and finishing the line with a three-cornered file.

In preparing material for frames, it will be found most convenient to plane it in short lengths, bearing in mind the size of the frame and that the strip should be a little more than twice its width longer than one side of the picture to allow for the miter cut.

To finish the pieces, sandpaper them well and stain them mahogany or some dark color with a commercial penetrating stain. Follow this with a coat of thin white shellac as a primer for the three coats of varnish that should be laid on. Each coat should be finely sanded after it is thoroughly dry. The final polish to the outside coat is given with powdered pumice and oil rubbed on with a cotton cloth.

Cut the completed strips to size in a miter box and, using a plane sharpened to a razor edge or a sharp chisel, clip off the rough surfaces left by the saw. Then fit the corners accurately and nail together with fine brads, after well coating the joints with glue. The larger frames may be held together with very thin, long screws, as illustrated.

The selection of the width, color, and design of the frames is necessarily left to the maker. No hard and fast rules can be laid down giving the size and proportions of the frame or mount. In general, it may



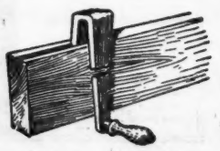
A few of the many moldings that can be made by combining bevels, rounds, carvings, and rabbets

be said that the farther away the picture is supposed to be, the wider the mount and frame should be. A landscape with considerable detail should have a narrow frame, while a portrait like that of Rembrandt by himself should have comparatively a much wider mount. The reason for this is that one function of the frame, from the artist's point of view, is to surround the picture with a space of "silence" or to blot out all disturbing details near the picture. A perfectly plain frame often sets a picture off better than one of the hand carved variety, which tends to call attention to itself and away from the picture.

When the frame is finished, visit a glazier and select a thin sheet of window glass free from bubbles. This should be cut 1/16 in. smaller than the dimensions of the glass rabbet. The glass, picture, and cardboard, wallboard or wooden backing are then placed in the frame and held with thin 1-in. brads. Over the back is glued a sheet of heavy wrapping paper to prevent dust from filtering down between the glass and the picture. The paper is moistened before gluing so that it will be as tight as a drumhead when dry.

Making Watertight Joints for Wooden Boats and Tanks

A SIMPLE trick by which the amateur woodworker can make a boat, tank, tray or watering trough watertight is to compress a groove into the edge of each board with a tool such as is illustrated. The edges are then planed until the surface is even again and butt joints are made in the usual way. When the boards come in contact with the water, the narrow strips of compressed wood swell and all cracks close tightly.



The grooving tool

A tool for making the grooves, if a forge is available, can be bent from a 10-in. length of strap iron, or one will be made cheaply by any blacksmith. The head of the tool is flattened to take the heavy hammer blows.—A. C. NAUDE, New York.

Don't miss the tool contest announced on page 90. Three prizes are offered for letters from readers.

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Secret Combination Safeguards Novel Electric Switch

ALTHOUGH simplicity itself, the secret electric switch illustrated cannot be operated successfully by those who do not know the combinations. It has hundreds of combinations and any would-be meddler will give up in disgust or tear it away to get at the connections concealed beneath it before hitting on the right sequence. As a switch to prevent the accidental or malicious closing of radio or experimental circuits it is, therefore, quite satisfactory.

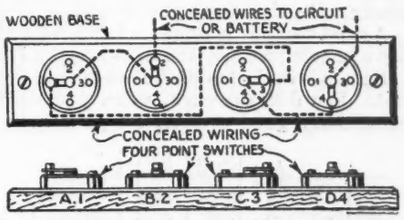


Diagram of quadruple switch block showing one of hundreds of possible "combinations"

Four switches of four points each are mounted on a suitable base. Various connections can be made between the switches, the one shown being simple and easy to remember. Number the four switches A, B, C, D, and number the points 1 to 4. Point 2-B connects with a concealed wire running to the circuit; the switch arm of B connects with the switch arm of A; switch A connects with point 1-A; that point connects with the point 3-C; the switch of C connects with point 4-D; and switch D-4 connects with the other concealed wire of the circuit.

The combination thus is A-1, B-2, C-3 and D-4. The number of switches used can be reduced or increased.—B. F. D.

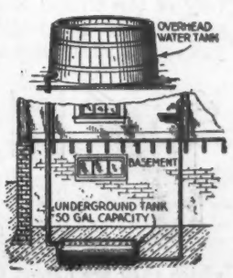
Tire Rim Forms Manhole Collar

WHEN a manhole is required in concrete work, a steel auto rim often can be used as a collar. This was done in one instance when three manholes were required in an alley adjacent to a garage. When the concrete was ready for pouring, three rims were taken from the scrapheap and used as shown, the beads forming a secure anchorage.—DALE R. VAN HORN.

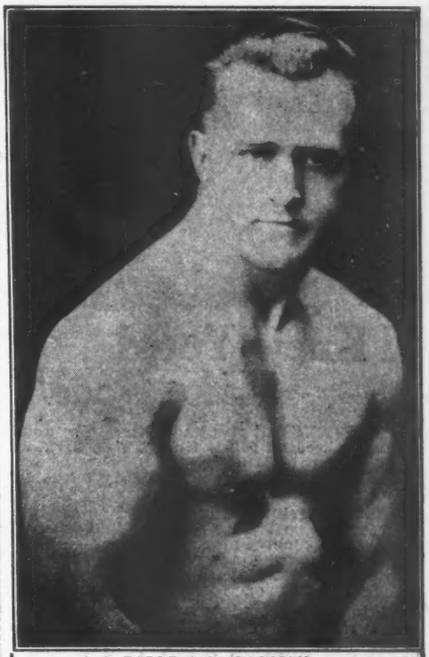
Buried Tank Keeps Reservoir Water Cool for Drinking

WHEN a home or factory is provided with a roof tank or water reservoir mounted so that it is exposed to the heat of the sun, the heat often makes the water insipid to drink and too warm for a cool shower bath. A good method for cooling it without the use of ice is to draw off the water through a tank of about 50 gals. capacity, buried under the basement floor.

The water that lies in the underground tank is frequently as much as 15 degrees cooler than that stored in the reservoir on the roof.—G. A. V.



The water is cooled in an underground tank



EARLE E. LIEDERMAN
as he is today

Some day a little bug is going to get you—

Germs are here, there and everywhere. They are in the air, in your food and the very water you drink. In fact, scientists say your body is full of them. They are only waiting for your vitality to weaken and then they are going to get you.

But what does a strong, healthy man care about all this? Once these terrible germs find your lungs breathing deep with oxygen and your heart pumping rich, red blood, they are going to run for their lives. A disease germ has as much chance in a healthy body as a fly has in a spider's web.

Food Was Meant to Eat

I don't ask you to give up all the good things in life. I make you fit to enjoy them. Everything was made with some purpose. Food was meant to eat and a healthy man has no regrets for satisfying his keen appetite. A man who takes the proper exercise craves food and must have it. Water was meant to bathe with—both inside and out. By drinking plenty of water you remove the waste matter within, just as washing your skin removes the waste matter without.

I MAKE MUSCLE

I am not a doctor—I don't claim to cure disease. That is a physician's job. But follow my advice and the doctor will starve to death waiting for you to take sick. I build strength and endurance. I make muscle. Follow my instructions and you will increase your arm one full inch in thirty days—yes, and put two inches on your chest in the same length of time. But that is only a starter. Meanwhile, I work on those inner muscles surrounding your heart and other vital organs which affect your entire physical being. You will soon feel the thrill of life pulsing through your veins. You will have pep in your old backbone. There will be a flash to your eye and a spring to your step. You will radiate vitality and have the strong robust body to put it over. I don't promise these things—I guarantee them. Come on and make me prove it. That is what I like, because I know I can do it.

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How to Drive a Nail

CONFIDENCE is needed in driving nails. Grasp the handle firmly and strike with precision, especially if you would rather not strike the wrong nail—the one on your finger.

A good hammer is properly balanced and has a handle precisely the right length. Do not grasp it in the middle but at or near the end. For delicate work, when you need particularly good control, let your index

finger and thumb reach up the handle. This gives a more flexible grasp.

Start the nail with a good blow, not a timid one, and make the hammer swings short and snappy. They should be jolts; far-reaching swings are not necessary.

See that the face of your hammer is clean. More bruised fingers come from a hammer in poor condition than from any other cause. Before using your hammer, rub it on a board, on the earth, or, if in very bad shape, on fine sandpaper.

If the hammer has no hole in the end of the handle for soap or wax, bore a ¼-in. hole about ½ in. deep and keep it filled with soap. When using finishing nails in hard wood, dip the point of each nail in soap. It will surprise you how much easier the nail can be driven.—A. E. ELLING.

Making Nails Hold

WHENEVER possible, drill holes before nailing, especially if the joint is to be subjected to much strain. The holes should be 1/32 to 1/16 in. smaller in diameter than the nails that are to be used. Nails driven into these holes will have, according to the Forest Products Laboratory of the United States Forest Service, considerably more resistance both to direct pull and to sheer than nails driven directly into the wood. Cement coated nails have holding qualities superior to ordinary nails. In general, the length of nails should be somewhat more than twice the thickness of the first piece into which they are driven (Fig.1). If the nails are driven slightly on the slant, or "toe-nailed" (Fig. 2), they hold better.—L. P. F.

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FRONT doors of the plank-faced variety, so popular in many Spanish and some English type houses, are usually sufficiently expensive to bar their use in homes of moderate cost. A southern California contractor, however, uses a method of building them for less than half the cost of millmade doors.

The core consists of an o. inary 1⅜-in. five-paneled stock door, which can be bought in his locality for about $3.75. A second-hand door will do, if the joints are sound. This door is about 1½ in. narrower than the opening, so that strips of wood of the kind to be used on the inside of the door can be glued to each edge.

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For the man or boy who has had little experience in woodwork, there will be an article, "Useful Tables Made without Mortised or Doweled Joints."

The new and valuable feature, "Home Workshop Chemistry," which begins this month, will be continued with practical suggestions on the use of glues and cements.

There will be the usual great variety of articles for the more advanced workers.

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The following IDEAS for Pressed Metal Articles, heretofore made of other materials, have already been purchased from readers of these advertisements who have taken advantage of the opportunity to cash in on their abilities.

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POPULAR SCIENCE MONTHLY

Most Wonderfully Illustrated Magazine in the World

October, 1923; Vol. 103, No. 4
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

SCIENCE and thought are inseparable twins. Each new discovery, each new invention, has the magic power of thought behind it. But an even more wonderful and more potent force is forethought. Forethought drives science forward to new achievements. It is forethought that permits the scientist to peer into the future, to look over the edge of the present and to see the needs of coming generations.

* * *

JULES VERNE was not a scientist, but he possessed the priceless gift of forethought. Fifty-four years ago, in "Twenty Thousand Leagues under the Sea," he fabricated a vivid picture of the modern submarine. Twenty-nine years later he prophesied that the United States would "have mighty navies, not only on the bosom of the Atlantic and Pacific, but in the upper air, and beneath the waters of the surface."

* * *

QUITE as amazing as these predictions, both of which have been fulfilled, is the prophecy of Admiral Moffett, chief of aviation, United States Navy, on page 30 of this issue. He pictures an airship 900 feet long, equal to the *Leviathan* in size, carrying a fleet of airplanes as ocean steamers now carry lifeboats, manned by a regiment of men and capable of encircling the globe in a couple of days. When such monsters of the air are practicable, they will draw the ends of the earth closer together. Its peoples will be united in closer understanding, and we may take week-end trips to foreign lands as we now drive into the country in our automobiles.

* * *

FORETHOUGHT and courage combined in one man produced a scientist who has been called the "supreme benefactor of the human race"—Louis Pasteur. The dramatic life story of this great Frenchman is told on page 57. It was Pasteur who discovered germs, who found a way of destroying them, who blazed the path on which all modern surgery and medicine walks. He was jeered at, called an ignorant charlatan. But he persevered and lived to see the scoffers at his feet. Millions are alive today who would be dead but for Pasteur. The whole world is this year observing the centenary of his birth and blessing his memory.

* * *

MOST of us, far from exercising forethought, do not use our brains enough even in the ordinary processes of thought. At least, that is the opinion which Dr. James J. Walsh, noted psychologist, expresses in a remarkable article on "Memory" on page 36. Doctor Walsh shows how, by the use of a simple "daily dozen" for the mind, all of us may strengthen our memories and make ourselves more efficient in carrying on the ordinary tasks of life.

* * *

FORETHOUGHT of the sort that carries even science into the future is being displayed today by Capt. Donald MacMillan, famous Polar explorer, who has sailed into the illimitable spaces of the Far North. He plans to plant landmarks on the glaciers so scientists of the future may know exactly when the next Age of Ice is coming. In a thrilling article on page 48 Captain MacMillan tells how he will carry out this extraordinary scientific work and how he will attempt for the first time to make radio waves penetrate through the Northern Lights, broadcasting messages to us from the frozen Arctic.

* * *

THE forethought of oil men and automobile engineers has furnished us with protection from the odd but fearful fire hazard that tiny sparks of static electricity may bring to motorists. How this is done is told on page 27. In fact, every article published in this number tells of something made possible by the magic power of forethought.

See Table of Contents on page 127

POPULAR SCIENCE MONTHLY

Issued monthly. *Single copy*, 25 cents. *Yearly subscription to United States, its possessions, and Canada* $2.50; *foreign countries*, $3.
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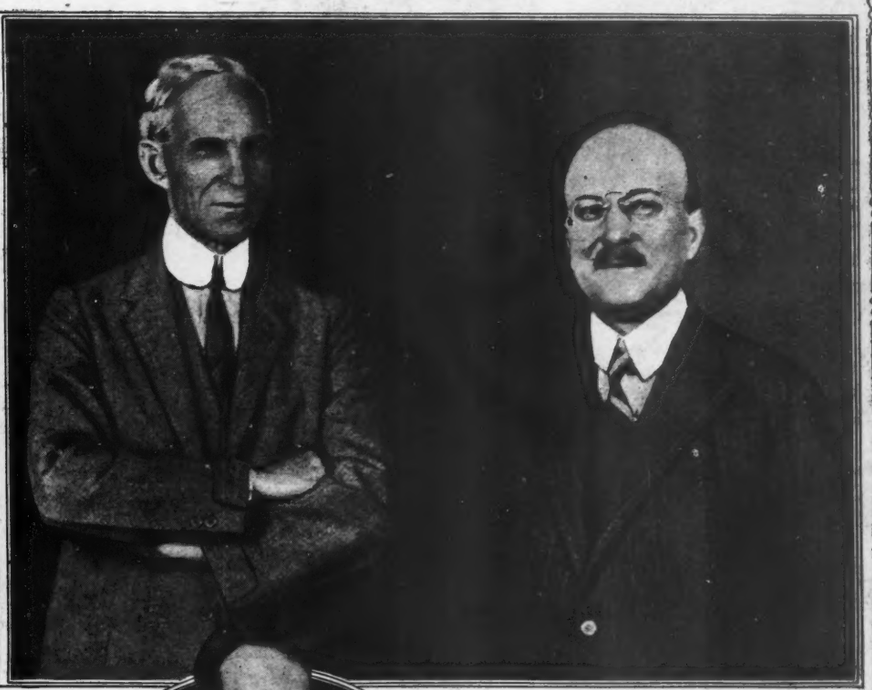
H. J. Fisher, *President;* R. C. Wilson, *Vice-President*
O. B. Capen, *Secretary and Treasurer*

THEY SAY—Brief Bits of Timely Comment on the Sciences of the Hour



PROF. A. M. LOW, the "Edison of England," whose wonderful invention for photographing noise has been used successfully in the London underground railways. He is shown above watching the motor races at Brooklands, Eng., where the exhaust noises of the competing cars were measured by his device:

"European scientists are on the eve of announcing one of the greatest discoveries of the age—flexible glass. I am confident that their experiments will prove successful within two years. Then we may possibly see the folding window-pane, the collapsible electric-light bulb and unbreakable dishes."

DR. E. F. PHILLIPS, head of the bee station of the United States Department of Agriculture at Somerset, Md., who has discovered many interesting new facts about bees:

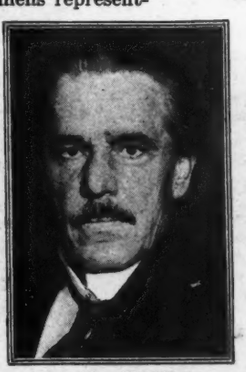
"The average bee, which weighs about 75 milligrams, will produce about seven times its weight in honey during its lifetime. Yet bees sometimes are lazy. Contrary to popular belief, the bee's sting is essentially for protection against intruding stranger bees."

ANDRÉ CITROËN, automobile manufacturer, known as "the Henry Ford of France" (at right), photographed with Henry Ford during the Frenchman's recent visit to America:

"I think there is plenty of room for more cars in America. Americans like something new and they like it quick and good. I intend to build a factory in America soon and expect to be manufacturing cars there by February. I have found that American engineers can give me great help in improving the rate of output and solving problems to which French helpers are unused. I have picked in America some skilled men, the like of which I had not found before, and they are to help me in my French plants. I expect by their aid to triple the output of my factory."

DR. ALES HRDLICKA, of the National Museum in Washington, D. C., and head of the American School for Prehistoric Studies in Europe, who is now directing a party of scientists visiting western Europe in search of prehistoric man:

"It seems to be becoming more and more likely that man himself originated in western Europe. Archeological specimens representing man's history from the earliest part of the Ice Age and possibly before have been recovered in great numbers from this field. The museums of Paris, Brussels, London, and Prague are filled with them. But vast deposits are still unexplored."



Dr. Ales Hrdlicka

DEAN ALBERT C. EYCLESHYMER, of the College of Medicine, University of Illinois:

"The search for the 'elixir of life' is about at an end; yet in this chase after eternal youth, medical science has succeeded in prolonging life 16 years. Regularity, plain diet, and exercise are the basis of longevity. We should all live to be 100 years old."

Sir Joseph Thomson

SIR JOSEPH THOMSON, British scientist and discoverer of the electron, who recently witnessed the progress of American engineers with his theory of electrons, and who now predicts that science will discover a new kind of water:

"The discovery of a substance that would break down one of the hydrogen electrons in the water molecule would make possible another kind of water. There is no reason why, with a strong enough agent, another kind of water could not be discovered."

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